POWER

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THE biggest room in the world is the room for improvement; it knows no limits; it reaches from the guest room in the White House to the ash pile in the yard of the isolated one-unit plant, from the Government official to the President, from the chief to the boy who sweeps up. There is always room and there always will be. Perfection is never reached in anything.

If an efficiency from certain apparatus of 75 or 80 per cent. is obtained, that is very good. How about the missing 20 or 25 per cent.; did you ever think of how it might be reduced? It is not impossible by any means; a hundred years from now they may only be wanting 16 per cent., but so long as the "wanting" is there, so will the room for improvement be.

The most important room for improvement that we directly control is the improvement of one's self. The road to it may be broad, but it may be easily narrowed; one thing sure, it never has the "closed" sign on it. It is not a hard road; it is easy if you know how to adapt yourself to it, to travel at the pace that improvement demands. To be on this road simply means having reasonable and sensible ambitions, being progressive and keeping abreast of the things which are needed in the business, being alive to the opportunities offered in life. When we stand still, when we think we "know it all" and would rather sneer at the fellow who is "plugging away at it," we are in that room adjoining of no-improvement, and ten to one the "plugger" will beat us out; just keep your eye on him.

To start and to keep on the road of improvement requires two things: common sense and a little personal effort. While we are lounging at the desk, listening to the "tune," we are offered a mighty good chance to better ourselves, to increase our knowledge by reading something worth while—not sensational newspaper stuff or comic supplements—for life is too short if one has a living to earn. Remember, the fellow who wrote it gets more material benefit than his reader; there is a difference between such class of matter and that of current topics.

While off duty, too, a man is continually given a chance to improve his ability. All of us have a little spare time if we work under normal conditions. Is there a public library in town, and do you ever go there to see if there are any practical textbooks which might be taken out for a few weeks? Do you ever read the publishers' announcements to see what "is doing" in the line of new, helpful books on the business, and which may be obtained for a dollar or two? Often a little money so invested has brought its investor manifold returns, not only in the room for improvement but in dollars and cents in salary. The greater our knowledge, the more we know how to act in our particular line, the more we get on pay day; and further, the fellow who really knows, and can put it in operation, rarely has to look for a job—the job looks for him

Did you ever notice the difference between the man who regularly gets a practical journal which keeps him uptodate, and the fellow who does not? And that other chap who comes around every few weeks and borrows the latest copy, and many times forgets to return it. "He can't afford to subscribe," but he probably expends many times the cost demanded when he meets friends at the "restaurant," at noon. The fellow who will not spend a nickel a week, less than one-half cent a day, to know what is going on in his world is the fellow who skips any word which relates to improvement; the big room of such as he is quite likely to always be big. He is in a rut and, not realizing, does not care; he is pretty sure to remain exactly where he is, and the fellow who is wide-awake need not fear him.

Our road will ever be large, but it should never be allowed to expand; each day should see a little traffic on it, and no matter how slight, it will always help. The liberties of existence accorded those of rational mind give to each individual his choice of routes—the one to improvement, betterment and the numerous possibilities contingent; the other, the road to nowhere, where he stands idly wishing, watching and waiting for the chance which never comes. Suppose it did come, where is he to "make good" in comparison with a progressive engineer?

Olympic and Titanic, Ocean Giants

The two largest ships in existence. The "Olympic", which is now in service, is propelled by two 15,000-horsepower triple-expansion engines and one 16,000-horsepower exhaust-steam turbine. She has a displacement of 66,000 tons, burns 800 tons of coal per 24 hours and makes 21 knots.

A mile is a considerable distance. To judge the accuracy of this statement you might get out and run a mile. If a mile run is too big a contract at the start, you might try a sixth of a mile, which contains 880 feet. Even the latter distance we feel will have your sincere respect after you have breezed over it and perhaps you will be able to appreciate in a small way the vastness of the two newest steamships of the White Star Line, the "Olympic" and the "Titanic," which are each 882 feet 6 inches long—more than a sixth of a mile. They are the largest ships in existence. Harland & Wolff, Limited, Belfast, are the builders.

The "Olympic" completed her first service trip at New York on June 21; she is to run between New York, Plymouth, Cherbourg, Southampton and New York. The "Titanic" is in course of construction at her builders' yards in Belfast Lough, and is to be practically the same in size and design as the "Olympic."

A view of the "Olympic" is given in Fig. 1. These are her principal dimensions: Length, 882 feet 6 inches; beam, 92 feet 6 inches; depth (keel to boat deck), 97 feet 4 inches.

From the keel to the top of the funnel is 165 feet; her gross tonnage is 45,000; her displacement tonnage is 66,000; there are 11 decks, four electric elevators to carry the passengers from one deck to another; accommodations for 2500 passengers are provided, and a crew of 850 is carried.

To propel this enormous mass at a speed of about 21 knots requires some 46,000 horsepower, 30,000 horsepower of which is developed in reciprocating engines and 16,000 in an exhaust steam turbine. The ship has three propellers; the reciprocating engines drive the outside ones and the turbine the middle one. This combination is most desirable as it increases two things which are important in ocean passenger steamer service: economy, and the comfort of the passengers. The use of a low-pressure turbine makes it possible to expand the steam much further than could be done in any reciprocating engine. Then the use of the turbine greatly reduces the size of the reciprocating engines compared with what would be necessary if engines alone were used and the ship had only two propellers, and this reduction decreases the noticeable vibration and consequently increases the comfort of the passengers. It may then be asked why turbines were not used exclusively and the noticeable vibration completely eliminated. The explanation is that the present arrangement is so satisfactory that an all-turbine installation would be but a very slight improvement in point of comfort while it would be at a decided disadvantage when reversing the boat.

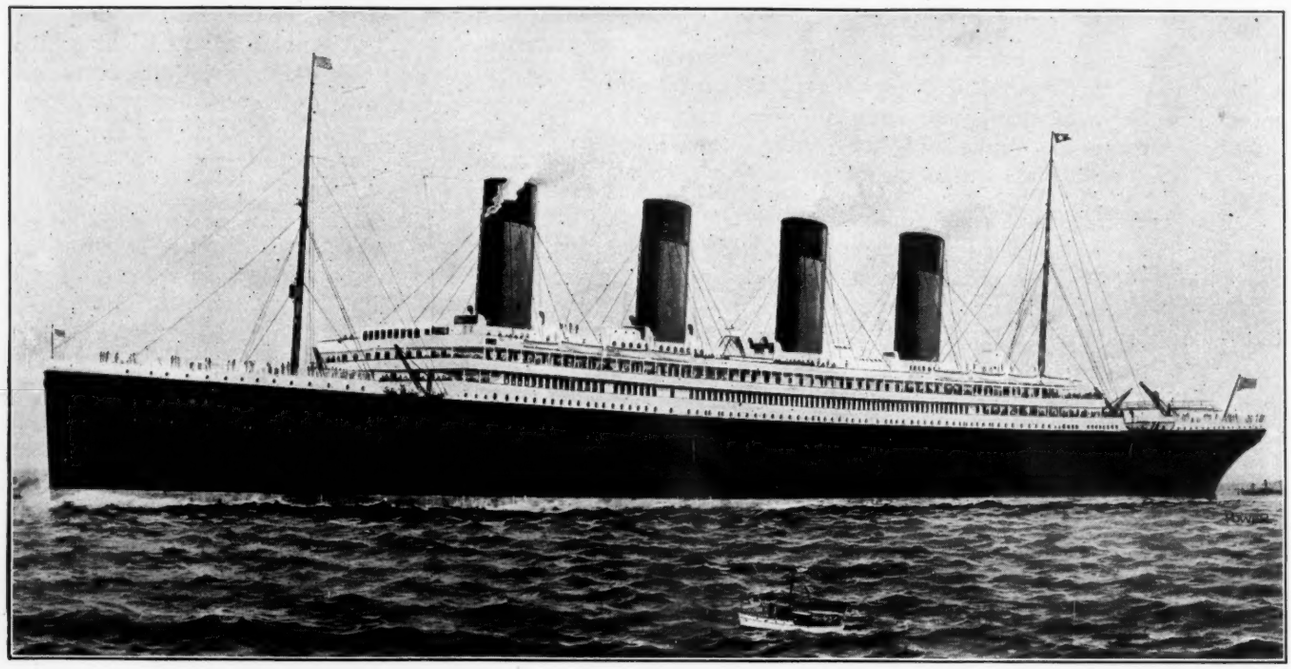


FIG. 1. THE WHITE STAR LINE'S NEWEST OCEAN LINER "OLYMPIC," LARGEST SHIP AFLOAT

RECIPROCATING ENGINES

The two reciprocating engines are of the four-cylinder, triple-expansion design, the high-pressure cylinder is 54 inches, the intermediate is 84 inches and the two low-pressure cylinders are 97 inches in diameter; the stroke is 75 inches. The engines were designed to operate at a speed of 75 revolutions per minute and develop 15,000 horsepower with a boiler pressure of 215 pounds and an exhaust pressure of 9 pounds, absolute.

LOW-PRESSURE TURBINE

The turbine is of the Parsons type. It receives steam at 9 pounds, absolute, and expands it down to 1 pound, absolute. The condensing equipment was designed to produce a vacuum of 28½ inches with the barometer at 30 inches and the temperature of the cooling water between 55 and 60 degrees Fahrenheit. The normal speed of the turbine is 165 revolutions per minute and it develops about 16,000 horsepower when operating under the conditions just described.

The rotor, shown in Fig. 2, is 12 feet in diameter and 13 feet 8 inches long be-

tween the outside edges of the first and last rings of blades. The blades range in length between 18 and 25½ inches. The casing is shown in Fig. 3, which gives a fair idea of the compactness of the turbine design. The rectangular opening at the far end of the casing is one exhaust outlet and connects direct to one of the two condensers which are on either side of the turbine. The position and outline of these condensers are shown in Fig. 4. The turbine complete weighs 420 tons. The propeller which the turbine drives is 16 feet 6 inches in diameter, has four blades and is made of manganese bronze. The two engine-driven propellers are 23 feet 6 inches in diameter, have cast-steel bosses and three bronze blades.

Arrangement for Reversing

Steam from the boilers is admitted to the high-pressure cylinder of each engine by a single piston valve, while the intermediate-pressure cylinder has two piston valves. The low-pressure cylinders are at opposite ends of the engine. Each of these cylinders has two flat valves worked off a common crosshead by a single set of double bar links and eccentrics.

The forward low-pressure cylinder, Fig. 4, discharges into a lap-welded steel exhaust pipe, which has a strap riveted over the weld. This pipe extends aft at the side of the engine, receives the exhaust from the after low-pressure cylinder and enters what is described as a "change-over" valve, which is used in cutting out the turbine when the ship is reversed; the turbine, not being fitted with a reversing gear, is stopped and the engines only are used to back water. There are two outlets to a "change-over" valve; one leads to a strainer from which the steam flows to the turbine inlet and the other leads direct to a condenser. A "change-over" valve consists of what might be called a deflector piston in a casing. When the piston is up the steam is admitted to the strainer and thence to the turbine; when the piston is down the steam is shut off from the turbine and admitted to the condenser direct.

The two "change-over" valves (one for each engine) are interconnected through a series of levers to a common Brown's hydraulic-cylinder reversing gear, which is supported on the bulkhead and operated from the engineers' starting platform by a lever near the reversing lever for the reciprocating engines. When the order to reverse is given, the engineer first pulls over the "change-over" valve reversing-gear lever, and then shifts the lever for reversing the engines. He need not wait an instant between these operations, for the steam supply to the turbine is completely cut off and the exhaust from the engines passes directly to the condensers.

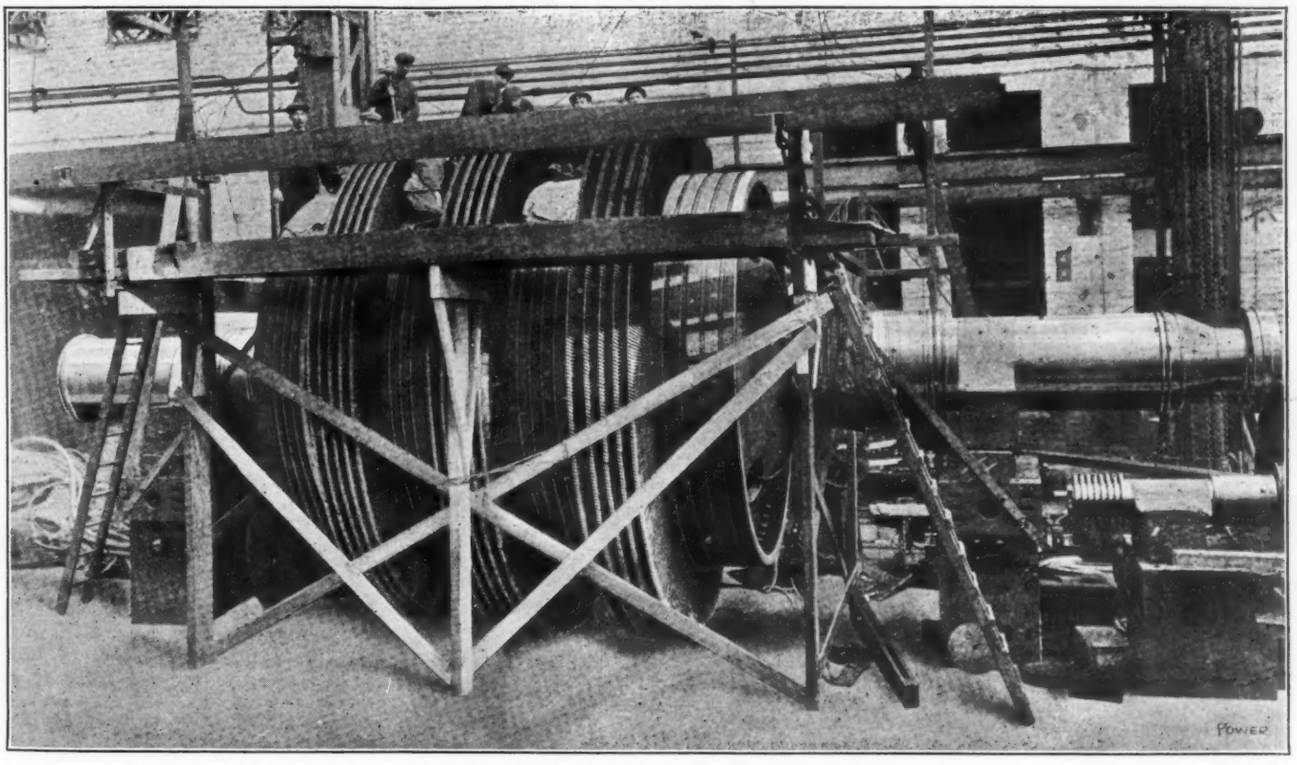


Fig. 2. Turbine Rotor for the "Olympic"

Piping

Each main-engine exhaust pipe is 5 feet in diameter. Expansion is provided for by placing "concertina" joints between all points where the pipe is rigidly connected. These joints consist of two concave disks of thin steel, 3 feet larger than the diameter of the pipe and riveted together at their periphery through a steel ring.

The high-pressure steam piping from the boilers to the engines is of welded steel and installed in duplicate right up to the engine-room bulkhead, where the main stop valves, 21½ inches in diameter, are located. Each valve is fitted with cross connections so that either system of piping may be used for either or both engines. Forward of the bulkhead there is a balanced emergency stop valve in each pipe, which can be closed in short order, when need be. In addition to the main stop valves there is an auxiliary valve on each engine, of smaller size but large enough to pass sufficient steam to operate the engines slowly; these valves alone are used when the engines are being handled, because they can be opened and closed more readily than the main valves.

As will be seen from Figs. 3 and 4, the turbine exhausts to the condensers through two rectangular holes near the top of the casing, one on each side. Each of these outlets is fitted with an electrically operated sluice valve so that the turbine may be completely shut off from the condensers in case of trouble.

The Boilers

Steam is generated in 29 boilers, 15 feet 9 inches in diameter; 24 are double ended and 20 feet long; 5 are single ended and 11 feet 9 inches long. There are three furnaces in the single-ended

boilers and six in the double, three at each end. The furnaces are of the Morrison type and all are 3 feet 9 inches in diameter. The boiler shells are of 1 11/16-inch plate and made with only one joint.

The boilers are contained in six watertight compartments. So great is the size of the ship that it was possible to set five boilers in a row athwartship. The after boiler compartment contains the single-ended boilers. These are so arranged as to be available for running the auxiliary machinery while the ship is in port, as well as for the general steam supply when the ship is at sea. Two boilers in each of two other compartments have separate steam leads to the auxiliary machinery, including, of course, the electric-lighting equipment. The five other boiler compartments contain the double-ended boilers; four contain five boilers each while, owing to the fining of the ship, the forward compartment contains only four.

In each of the five large boiler compartments there are two See's ash ejectors, and in addition there are four Railton & Campbell's ash hoists for use when the ship is in port.

A duplex pump, manufactured by Harland & Wolff, is contained in a separate room in each boiler compartment. The advantage of having the pump in a separate room is that the dust is excluded, and hence the working parts are not affected. This pump works the ash ejectors and feeds the boilers as required; it can also be used for pumping the bilges, except in three of the compartments in which there are independent ballast pumps.

Air is supplied to the stokeholds by electrically driven Sirocco fans, of which there are 12, two for each boiler room. The boilers are operated under natural draft furnished by three of the four funnels, the fourth being used exclusively for ventilating purposes. The funnels rise 150 feet above the grate bars and are oval in shape, 24 feet 6 inches by 19 feet. Each stokehold is provided with Kilroy's stoking indicators—electrically operated signal disks and gongs, which inform the fireman when each furnace is to be stoked. The instruments are so set that the minimum number of doors are open at a time and no two opposite doors in the same boiler are ever open during the same period. The interval between the times of firing is determined by the engineer and changed as his judgment may decide, but when the instrument is once set, perfect regularity is secured and economy is increased.

The boilers are fitted with Silley wedge-action smoke-box door fasteners, which do away with the usual multiplicity of handles and tend to keep the doors from warping. A complete telegraphic outfit is used to inform the boiler-room force of the requirements of the engine room in regard to steam, etc.

There is a main coal bunker 'tween decks immediately within the skin of the ship. The coal is first loaded into this and subsequently distributed into bunkers athwartship at the stokehold level. These bunkers are arranged on each side of the main bulkheads and, therefore, immediately in front of the furnaces; hence, each fireman practically takes his coal from the bunker door.

The coal consumption amounts to something like 800 tons per 24 hours. About 175 firemen and some 72 trimmers are carried.

Electric-generating Plant

Those who remember the early days of the introduction of electricity on board ship, when any old otherwise useless corner was good enough in which to stow the dynamo, would appreciate the great importance to which this department has now attained on board ship after an inspection of the palatial room devoted to the generating plant on the "Olympic."

There are four 400-kilowatt engine-driven dynamos. The engines, which indicate each about 580 horsepower, are of the Allen vertical, three-crank, compound type and run at 325 revolutions per minute. Each engine has one high-pressure cylinder, 17 inches in diameter, and two low-pressure cylinders, each 20 inches in diameter; the stroke is 13 inches. The engines take steam at 185 pounds pressure. They exhaust either into a surface heater—which is the usual sea-going condition—or to the condensers.

Forced lubrication is, of course, used, with special arrangements to prevent the oil from getting into the cylinders and thence to the boilers.

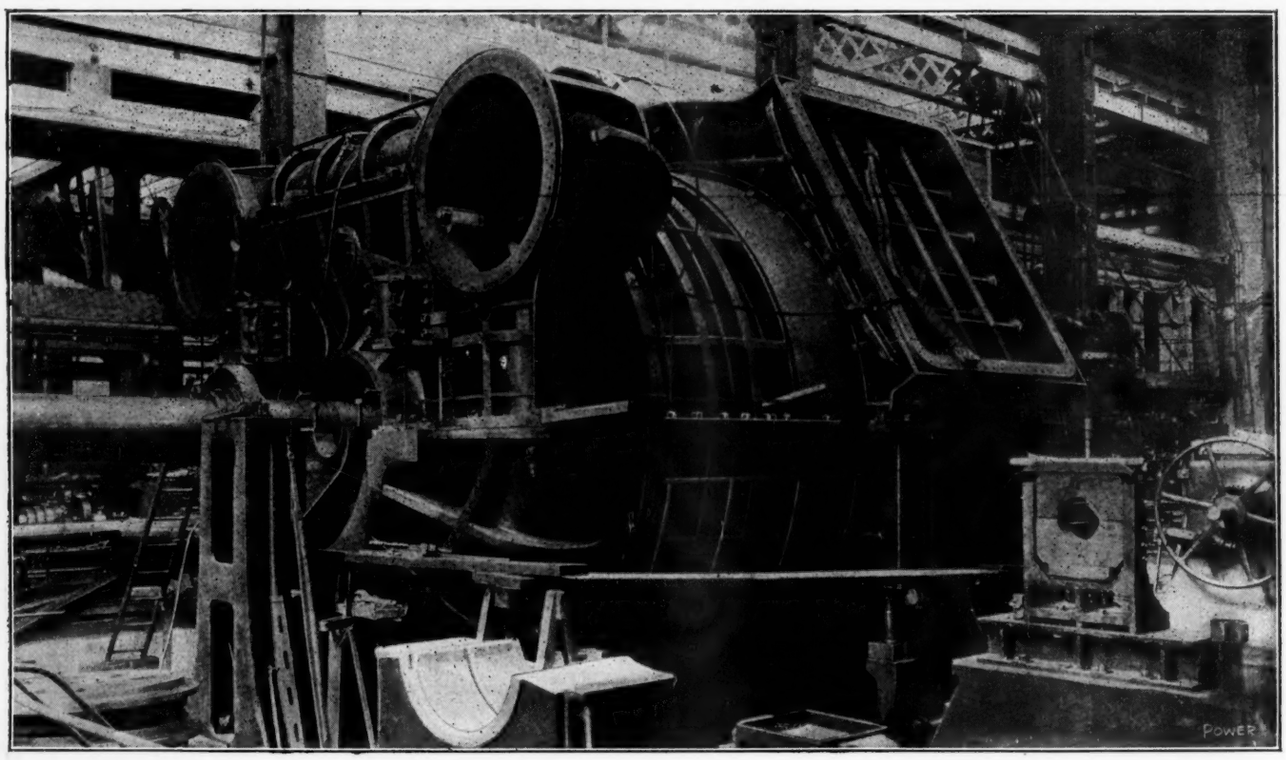


Fig. 3. The "Olympic's" Turbine Casing on the Assembly Floor

Each engine is direct coupled to a compound-wound direct-current dynamo, having an output of 4000 amperes at a pressure of 100 volts. The dynamos are of the ten-pole type and are fitted with interpoles.

In addition to the four main generating units there are two 30-kilowatt engine-driven dynamos, in a recess off the turbine room at the saloon-deck level. These sets can be supplied with steam from either of several of the boiler compartments and hence are available for emergency purposes. They are of a similar description to the main sets except that the engines are of the two-crank type.

The distribution of current is effected on the single-wire system, and is controlled and metered at a main switchboard placed on a gallery in the dynamo room to which the main dynamo cables and the main feeders are connected. The latter pass up through port and starboard cable wells to the various decks radiating from thence to master-switch and fuse boxes scattered throughout the vessel, controlling the lamps, motors, etc.

Disastrous Air Explosions

Violent explosions have on several occasions occurred in air compressors on the Rand, fume and poisonous gases descending the air mains to the workmen below with calamitous results; on one such occasion over 100 men were "gassed," some of them fatally. These explosions, which also occur in other mining fields, are brought about in the air cylinders of compressors as the result of carelessness, the use of too much oil, or poor qualities of oil, for lubrication in the cylinders, or defective or leaking delivery valves. Any of these only results in the ports and valves being obstructed by a deposit of carbon, and this is apt to bring about a high temperature. Air cylinders may be cleaned by soft soap and water; kerosene and similar inflammable oils should never be used for this purpose. A thin oil, with very little carbon in it, and with a high flash point is the best lubricant for the air cylinder. The explosions in compressors frequently arise from the breaking or sticking of the air-discharge valve, which results in some of the hot compressed air returning to the cylinder, and the additional heat given to this air by the recompression is such as to ex-

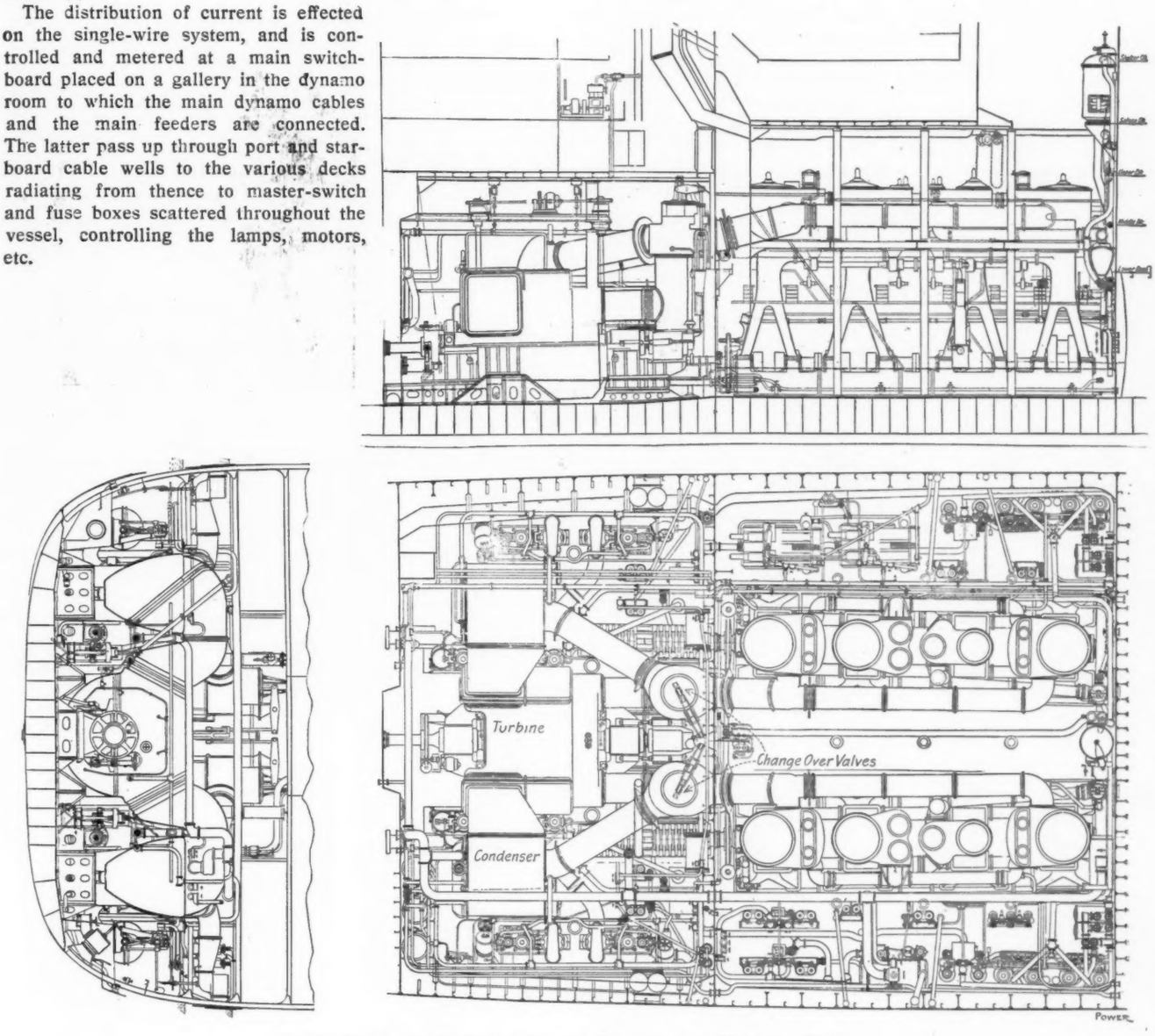


FIG. 4. PLAN AND SECTIONS OF THE ENGINE AND TURBINE ROOMS

With the exception of Fig. 1, the illustrations accompanying this article are reproduced from *The Engineer*, of London, and much of the information contained herein was derived from the same source.

may cause the cylinder-lubricating oil to char and the resulting gases to ignite and explode. Very little lubricating oil is needed in the air cylinders—less than in a steam cylinder; good oil in small quantities should be used; an excess of oil ceed the flash and ignition point of the oil present, which, therefore, vaporizes and explodes. The ports and valves of compressors should be periodically inspected if accidents are to be avoided.—*Mines and Minerals.*

Features of the Leblanc Air Pump

By R. N. Ehrhart

This type of pump works on the principle of entrapping and removing the air between laminæ of water. At high vacuums it has a much greater volumetric efficiency than the reciprocating pumps.

In Fig. 1 is a cross-section of a Leblanc jet condenser built for a 10,000-kilowatt Westinghouse double-flow steam turbine. The connecting pipe between the two turbine exhausts is utilized as part of the condenser and contains the atmospheric exhaust *A*, the injection-water connection *B*, and the water-spray nozzles *C*.

The steam entering through the two top openings is brought into contact with the water issuing from the spray nozzles and is condensed, the mixture of water and condensed steam falling through the large cone into the entrance of the centrifugal pump which removes it to the hotwell or cooling tower.

On the right-hand end of the shaft is located the air pump. This is in a separate chamber from the centrifugal pump. The water used in the air pump is taken from the cold well and may be discharged

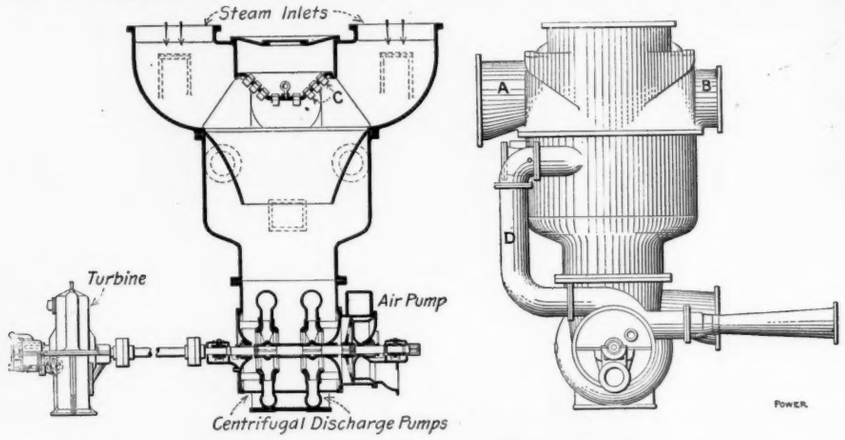


FIG. 1. LEBLANC JET CONDENSER IN SECTION AND ELEVATION

back to the same place if desired, as it is heated less than 1 degree in passing through the pump. The air is withdrawn from the condenser through pipe *D* which is attached at a point where the condensation is complete so that no live vapor is drawn into the air pump. No precooling is necessary, as the water passing through it instantly cools the air at the time of pumping.

Fig. 3 represents a section through the air pump. Water enters at *E*, the revolving annulus of blades *F* cutting off the laminæ, which are thrown downward through the diffuser *B* and between these laminations large volumes of air are entrained. In commercial operation it is not unusual to exhaust seven volumes of air to one of water. This is a striking result when it is borne in mind that by the employment of a jet of water in the most refined type of air ejector or aspirator, only about 1¼ cubic feet of air are ejected per cubic foot of water. In this case friction between the water jet and the air is alone relied upon to propel the air, while in the Leblanc pump an entirely new principle is utilized; namely, the continuous formation of a succession of water pistons, which act without the ill effect of restriction through valves and ports, and the consequent re-expansion of the air in clearance spaces.

The higher the vacuum maintained with a Leblanc air pump, the greater its volumetric efficiency. This is because the air is removed by the impact of the laminæ of water, and if the vacuum is high, the less the mass of air between the water laminæ the more effective the ejection of the air. On the other hand, with a reciprocating pump and a high vacuum, the removal of a certain amount of air requires the velocity through the valves and ports to be a maximum; consequently there is a material loss in vacuum caused by friction and wire drawing. Furthermore, reëxpansion in the clearance space and air leakage are most injurious at a high vacuum. Fig. 4 gives the results of a test of a reciprocating air

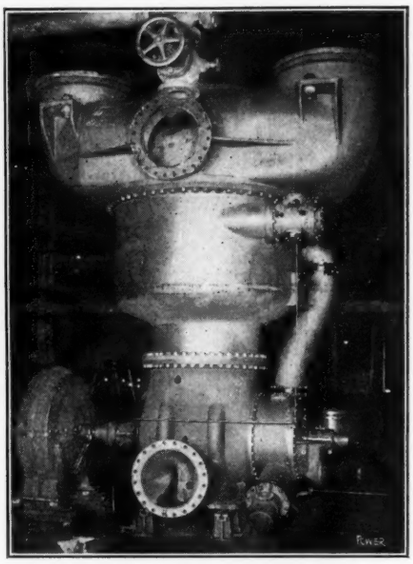


FIG. 2. LEBLANC CONDENSER ON TESTING FLOOR

pump compared with that of a Leblanc pump. This shows that at a high vacuum, the Leblanc pump is superior; whereas, at a low vacuum the reciprocating pump makes the better showing. In other words, if the power consumptions were identical the Leblanc pump would be superior when working in the region above *B B* and inferior below *B B*.

Where condensers are used with steam turbines, an increase of ½ inch of vacuum means a decrease of about 2 per cent. in the steam consumption and an equivalent increase in overall economy, which would almost compensate for the whole power consumption of the condensing apparatus.

In this connection it may be of interest to refer to some facts brought out in a

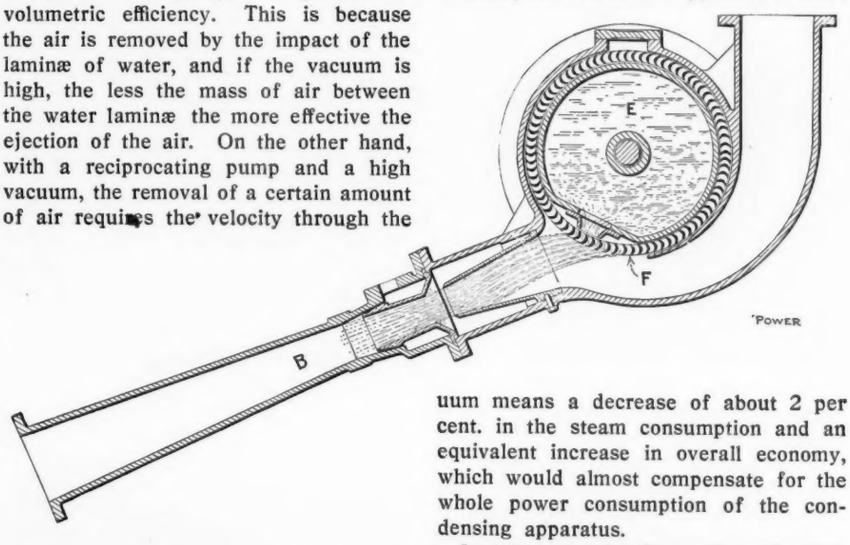


FIG. 3. SECTION THROUGH THE AIR PUMP

recent installation of a surface condensing plant equipped with a Leblanc air pump. In this particular plant a high vacuum was desirable as the condensers were used in conjunction with steam turbines. The reciprocating air pumps were giving fairly good results, but were not quite large enough and it was decided to install greater air-pumping capacity either by putting on larger air cylinders, pur-

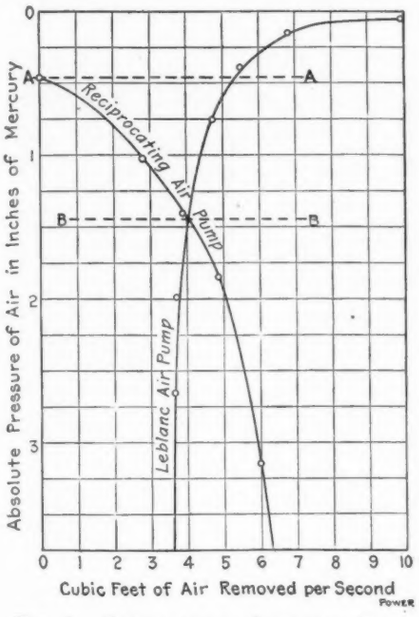


FIG. 4. COMPARATIVE AIR-PUMP TEST RESULTS

chasing a new reciprocating pump, or installing a Leblanc air pump.

The Leblanc pump for this work, while requiring 40 per cent. more power for its operation than the reciprocating pump, had a capacity substantially the same as the reciprocating pump for a vacuum of approximately 28 inches of mercury, but with a vacuum of 29 inches its volumetric capacity proved to be practically three times that of the reciprocating pump. The net result was that the Leblanc pump permitted the maintenance of 3/8 inch better vacuum under winter conditions, and the increased economy of the turbine offset the increased power consumption of the air pump.

A type of Leblanc air pump designed for marine work is shown in Figs. 5 and 6. The pump is driven by a steam turbine, which is shown at the left-hand side of Fig. 6.

Colors of Piping

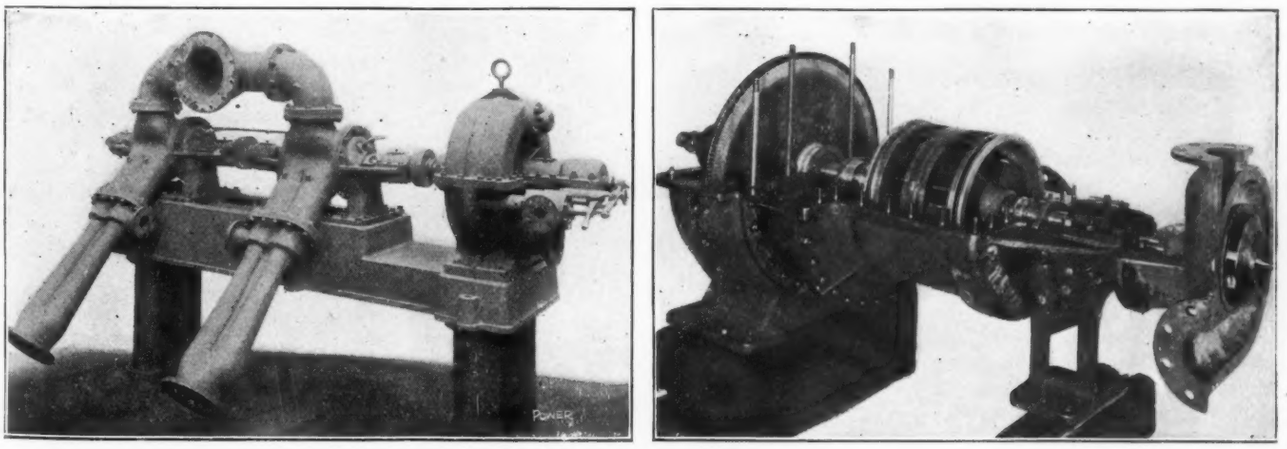
BY C. H. BENJAMIN

Power-plant managers and operators have given more or less attention to the identification of piping by colors, but there are a great number of colors used and an apparent lack of system. Undoubtedly, this has discouraged many owners and engineers of small plants from attempting to carry out any such scheme. In a large plant where numerous auxiliaries of different sorts are in use in addition to the main units it doubtless pays to paint drips, blowoffs, hot-water returns, etc., but in a small power house this is hardly necessary.

Where several units are installed a certain amount of coloring will save both labor and time. Some engineers are inclined to ridicule any such kindergarten methods as tending to show ignorance on the part of the employees and claim that every engineer, fireman and helper ought to know the different pipes without any such assistance. The same argument may be used against any color scheme employed as a means of identification. In a shop, if the material cards are pink and the time cards blue, it does not imply that the employees cannot distinguish between the two cards without the use of the colors; it merely furnishes an additional means of identification which saves time and trouble and prevents mistakes. Furthermore, in the piping scheme the use of colors shows the general layout of the plant at a glance and makes it easier to keep the arrangement symmetrical and uniform when additions or repairs are contemplated. In fact, it is unnecessary to argue for the advantage of such coloring; it only remains to suggest how this may be done without unnecessary expense or complication and can be adapted gradually to the needs of a growing system.

The primary colors should be used for the different classes of service, leaving the shadings and secondary colors for minor distinctions. White is used for high-pressure steam lines as being the natural color of the protective covering. If two pressures are used the lower pressure may be painted buff. The use of superheat on either line can be readily indicated by a different color of band or by coloring the edges of the flanges. Exhaust mains would naturally be painted drab or black, using the ordinary varieties of carbon paint. If there are two exhaust mains, one leading to the atmosphere and the other to a condenser, the former may be painted black and the latter a dark drab. Cold- and hot-water pipes may be painted blue and red respectively, the colors being from their nature suggestive of temperature. In case there are two sources of cold-water supply two shades of blue can be used. If there are two different systems of hot-water piping, one perhaps being the returns to the boiler and the other the circulating water of the condensing system, two shades of red can be employed to distinguish these. Green is used for gas mains because of the alliteration and different shades may be used for artificial and natural gas. Yellow is about the only primary color remaining and this may be applied to air mains and, as in the cases just mentioned, dark and light shades are available for different pressures or temperatures. There are still left some secondary colors such as the browns and the purples which can be used for refrigeration piping and for drains and drip lines.

The mere indication of live and exhaust steam and hot and cold water by the colors suggested will be sufficient in most small plants and further details can be added as the complexity of the piping increases. These are about all the desirable shades, since all become more or less dingy with age and too fine gradations cannot be employed.



FIGS. 5 AND 6. TYPE OF LEBLANC AIR PUMP, DESIGNED FOR MARINE WORK

If still further distinctions are necessary, it is better to make them by coloring the edges of the flanges or by painting the unions and couplings on the screwed pipe. For instance, red flanges on a white steam-pipe line might show high-pressure steam superheated, the red suggesting a high temperature, while a high-pressure water line for hydraulic service might be distinguished from the other lines at the same temperature by blue pipe with red or yellow fittings.

If the system of piping is extremely complicated, as it is liable to be in a power house where gas, compressed air and ammonia are used in addition to the ordinary media, the painting of white or jet-black arrows on the piping to indicate the flow of the fluid is desirable.

Perhaps the best illustration of the needs of some such system as has been outlined would be the power plant of a large hotel or business block in the city where all of the fluids mentioned are in common use. Let each superintendent or engineer begin the coloring on some such lines as indicated, taking the main distinctions first and adding the others gradually as experience dictates and the advantages will soon become apparent.

There is more or less of a psychological effect on the employees when there are such evidences of system and orderly management as colored piping indicates. If a boiler or engine room is in disorder and the eye is confused and wearied by the lack of system, a little medicine of this sort has a decidedly good effect on the employees, very much as the installation of racks, closets and pigeonholes for spare parts improves the morale of the whole working force.

Results of the Boston Anti-Smoke Law

By Benjamin Baker

This law which was enacted last year has not only eliminated to a large extent the smoke nuisance, but also has aroused among the engineers a keen interest in the problem of combustion.

Six months' experience with the enforcement of a comprehensive smoke-abatement law in Boston and several of the adjacent cities has shown that it is comparatively easy to decrease a large portion of the smoke nuisance when the task is properly undertaken. It shows also that in a great majority of plants, more particularly the small ones, the blame for excessive smoke production really rests with the engineer. When the engineer fails to instruct his fireman in the proper methods of firing, or having instructed him, neglects to see that his instructions are carried out, he is not doing his whole duty to his employer.

A large part of the work in Boston has been the instruction of engineers and firemen in the best ways of handling their particular plants. The smoke inspector is W. H. Gerrish, who has had a long experience with the mechanical and power end of manufacturing plants. It has been the policy of the State board to coöperate, as far as possible, with the owner and the operating force of every power plant which offended against the law. The law itself, as was explained in detail in the April 19, 1910, issue of POWER, is drawn up with scientific precision; it establishes standards which are tested by the Ringelmann smoke chart and provides explicitly for the imposing of penalties.

In the large plants of Boston the mechanical stokers appear to satisfy the requirements of the law, but it is in the smaller plants that most of the violations have been encountered. There are, for instance, about 25 plants which burn wet wood shavings and which have been very offensive as smoke producers. The chief remedy in these cases has been to cut down the bridgewall practically to a level with the grate bars. The wet shavings are generally fed to these furnaces in an air blast which enters over the fire doors. Experiments showed that after being ignited this mixture was deflected upward by the bridgewall against the boiler and the cooling which resulted not only caused smoke but a considerable loss of fuel value. As the feeding of shavings in such instances is more or less intermittent and the quantity delivered varies, some plants have found it useful to keep the furnace doors open half an inch or so all the time.

About half a dozen plants in the city are noteworthy illustrations of the principle that the furnace and the fuel must suit each other in order to obtain good results. The inspection has disclosed six Wellington boilers designed for burning hard coal which have been fed with soft coal, and the result has been excessive smoke which it is very difficult to lessen except by a change of fuel.

Steam jets have proved to be another prolific source of trouble. If the testimony of engineers and firemen can be taken at its face value, agents of steam jets for forced draft have been active in selling their appliances in Boston, but have neglected to inform the engineers and firemen as to the best way of using them.

One of the important tasks of the smoke inspector has been to show how much can be accomplished by a little careful experimenting, directed by even a moderate amount of engineering "horse sense." In a large proportion of the plants inspected it appears that in order to avoid undue smoke the coking method of firing is necessary. The spreading system will also serve, but its weak points, so far as the human element is concerned, are well known. Special conditions in some plants have made alternate or side firing desirable.

Naturally, the enactment of a new anti-smoke law has brought to Boston a flood of patented devices for preventing smoke, among which only two seem to have made any great impression in the way of practical results. One of these devices consists essentially of a steam jet suspended in firebrick over the middle of the furnace and discharging toward the opening between the bridgewall and the boiler. It is asserted by the agents for this device that the discharge steam is decomposed. At any rate, the position of the jet is marked by an intense flame and the few plants that are trying the steam jet are inclined to look upon it with some favor. It has not been long enough in use, however, to show how well it will endure the action of the furnace heat.

Another method consists essentially of a dutch oven opening from a transverse wall two or three feet back of the bridgewall. The latter contains an air space communicating with the ashpit, through which air is drawn by small steam jets and discharged by a row of tuyeres so as to mingle with the smoke and gases passing over from the fire. The dutch oven is practically incandescent and completely consumes the smoke and unburned gases which come to it mingled with the hot air supplied from the tuyeres.

Aside from the benefit to the general public resulting from a great lessening of the smoke nuisance, considerable interest has been aroused among the engineers and firemen. Until lately, the engineers of the numerous small plants have not held themselves responsible for the proper firing of their furnaces. Six months of the new law has shown that perhaps 20 per cent. of the firemen do not care whether they fire well or otherwise, providing they can hold their jobs. But the great majority of the firemen have proved to be merely more or less ignorant; they have shown an entire willingness to learn how to do their work in the best way. The engineers have received a jolt that in many cases has been rather severe. The result is that in the power plants of Boston there is a new spirit of engineering keenness and responsibility, and a realization that it is worth while to get the best possible results out of a power plant.

Efficiency of Rope Drives

At a recent meeting of the Engineers' Society of Western Pennsylvania, Professor Trinks presented a paper upon the "Efficiency of Rope Drives." It was devoted largely to a comparison between some tests performed at the Carnegie Technical Schools and those carried out under the direction of the Society of German Engineers.

The German tests were made with powers up to 200 horsepower, the input and output being measured by carefully calibrated electric motors and dynamos. The rope pull and the influence of centrifugal force were measured by a hydraulic support. Both the English system of drive—independent ropes in parallel—and the American system—one continuous rope—were employed.

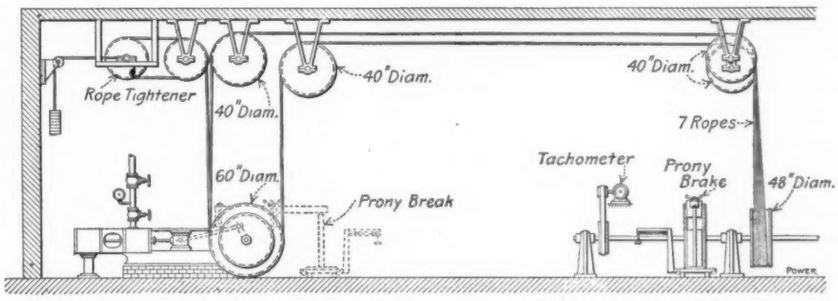


FIG. 1. DIAGRAM OF ROPE DRIVE IN CARNEGIE TECHNICAL SCHOOLS

In the tests at the Carnegie Technical Schools a 100-horsepower steam engine was employed to drive a lineshaft through a continuous-rope drive and the power was measured with a prony brake. The tension of the slack rope was maintained constant by exerting a constant force of 356 pounds on the tension carriage. Fig. 1 is a diagram of the drive.

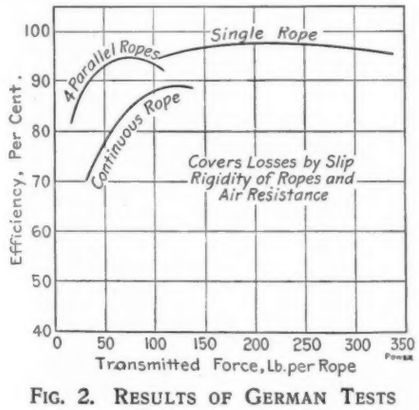


FIG. 2. RESULTS OF GERMAN TESTS

Fig. 2 represents the results of the German tests. It shows that with only one rope on the sheaves, efficiencies of over 97 per cent. were attained, the efficiency remaining high over a wide range of transmitted power. With several ropes, however, the range of high efficiency was very much reduced. Also, the results of these tests would seem to indicate that the continuous-rope drive is inferior to the parallel drive; but considering that the sheaves used were not adaptable to the continuous drive, the apparent results cannot be accepted as conclusive.

In comparing these results with those of the tests at the Carnegie schools, which are given in Fig. 3, it will be noted that the results are very similar. The latter efficiencies were actually higher than indicated, however, for as given they include the bending of the ropes over two additional pulleys and the bearing friction of these two pulleys. Reduced to a basis of the German tests the Carnegie Technical Schools' tests show efficiencies over 92 per cent. The diameters of pulleys were found to have direct influence; the smaller the pulley the lower the efficiency.

Another item investigated by the German commission was the influence of an idler. In this connection it was found that, with pulleys of 100 and 60 inches in diameter and a 40-inch idler, the efficiency of the drive dropped off 10 per cent., due to the presence of the idler.

Effect of Soot on Boiler Performance

Some tests were made recently by J. J. Coughlin, chief engineer of the Champion Coated Paper Company, of Hamilton, O., to determine the relative effects of clean and soot-covered boiler tubes. The results are herein tabulated and present some interesting features.

In every case, with clean tubes, the temperature of the gases entering the economizer was lower than with dirty tubes. This is in line with what would be expected, showing that more heat was extracted from the gases with clean tubes. The stack temperatures were also lower.

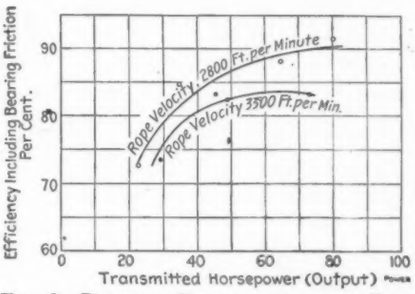


FIG. 3. RESULTS OBTAINED AT THE CARNEGIE SCHOOLS

It will be noted that in test No. 2 there was no gain from the use of a soot cleaner when the economizer was in service. This may seem puzzling at first, but upon closer inspection it will be seen that the percentage of CO_2 was greater when taking the readings with dirty tubes than with clean tubes. Hence, the gain in heat transmission due to clean tubes was offset by incomplete combustion in this particular case.

	Test No. 1. Coal Used, Cando Gas, Run of Mine		Test No. 2. Coal Used, Cando Gas, Nut and Slack		Test No. 3. Coal Used, Kayford No. 2 Run of Mine	
	Before Cleaning	After Cleaning	Before Cleaning	After Cleaning	Before Cleaning	After Cleaning
Date of test	April 26	May 15	April 28	May 13	May 4	May 16
Duration of test, hours	10	10	10	10	10	10
Heat value of coal, B.t.u.	14,171	14,279	14,416	14,393	14,459	14,554
Ash, per cent	11	11.7	12	12	12	11
Moisture, per cent	0.86	0.69	3.6	1.005	1.08	1.89
Average steam pressure, pounds	150	151	150	151	150	152
Average temperature of water to boiler, degrees	253	219	250	226	244	234
Average temperature of water to economizer, degrees	167	172	165	171	165	175
Coal fired, pounds	20,929	18,661	19,305	19,821	19,658	18,500
Water evaporated, pounds (corrected to feed water at 100 deg.)	199,686	191,671	181,528	196,639	189,429	188,598
Equivalent evaporation per pound of coal without economizer, pounds	9.62	10.76	9.84	10.14	9.88	10.66
Equivalent evaporation per pound of coal with economizer, pounds	10.5	11.36	10.7	10.7	10.68	11.29
Gain from use of economizer, per cent	8.94	5.28	8.75	5.5	7.5	5.6
Average temperature of gases to economizer, degrees	669	502	622	496	569	530
Average temperature of gases to stack, degrees	500	384	482	376	426	394
Horsepower developed	601	610	539	609	603	594
Per cent. of boiler rating	200	205	180	204	201	198
Average CO_2, per cent	....	13.64	15.08	12.06	12.6	12.35
Average draft entering economizer, inches	0.2	0.2	0.4	0.35		
Gain from use of soot cleaner without economizer, per cent	....	10.6	....	2.95	....	7.3
Gain from use of soot cleaner with economizer, per cent	....	7.57	....	0	....	5.44

The Steam Turbine in Germany

By F. E. Junge

A description of the Brown-Boveri turbine which is a combination type, employing the Parsons blading in the low- and medium-pressure elements and a single-stage wheel in the high-pressure element. Special attention is given to the method of regulation.

At the outset of this series it was shown that the scientific treatment of the problems which attend the design, construction and application of steam turbines, together with the execution of practical tests, has ultimately defined those limits within range of which the different types of turbines have a chance for further development. Great innovations or revolutionary changes, which would have an appreciable effect on the economic ranking of the steam turbine as a prime mover, are no longer to be expected. The system becomes a secondary consideration as compared with the constructive usefulness, and the success of the perfected machine depends more than ever upon the correct treatment of the working fluid, the conscientious elaboration of details, and the good quality of materials employed.

The growing number of firms engaged in the building of steam turbines and the pressure of competition have induced manufacturers, instead of devoting their time and capital to new inventions in that line, to concentrate their best energies exclusively to standardizing their output in order to reduce the cost of manufacture and to increase their profits. In the manufacture of steam turbines, as in every other line of industry, it would appear that the selling end of the business has outgrown the creative end; that is, the financial forces have repressed the technical forces of the concern. Yet it is remarkable that what is often justly called "unscientific secrecy," or the tendency of builders to surround their shops with impenetrable walls in order to protect and exploit specific modes of construction, has been responsible for much of the progress which was made by other practitioners of the art, who were forced to devise new methods of their own in order to establish a competency and a profitable business.

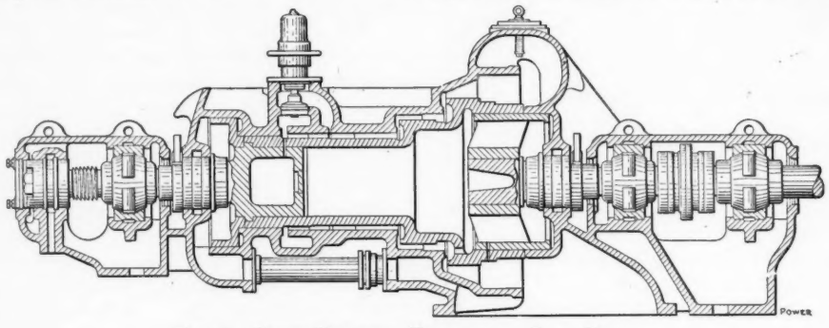


FIG. 1. PURE PARSONS TYPE WITH ONE DRUM

The Brown, Boveri-Parsons steam turbine was introduced and developed on the European continent by the firm of Brown, Boveri & Co., at Mannheim, Baden. In its latest form it is an embodiment of the now general tendency to sacrifice specific features to standard equipment, and to discard old principles which, at one time, were considered as fundamental. The replacement of many high-pressure stages by a single partially impinged high-pressure wheel has many advantages, resulting in reduced cost of construction, smaller bulk of machine, and lower pressures and temperatures acting on the stuffing boxes and casing, owing to the wide expansion of the steam in the high-pressure wheel. From the purely physical point of view, the superiority of the Parsons blading over other types is defendable as long as the length of blades does not necessitate the width of the annualr steam space being decreased below a certain limit. This condition can be met by reducing the diameter of the drums. Very short blades have an unfavorable effect upon the efficiency. This is due, not so much to the leakage losses, as to the fact that with short blades the disturbing influence of the walls and blade ends on the outer strata of the steam is more severely felt than with long blades and a thick stream. Therefore, the smaller the volume of steam which flows through the turbine in a unit of time, the smaller must be the diameter of the drum. The smaller the diameter of the drum, however, the lower the velocity of the blades at a fixed number of revolutions per minute and the amount of heat which can be utilized in one stage is also decreased; furthermore, the number of stages required for the complete utilization of the total heat drop becomes greater. When the number of stages grows to such an extent that the mechanical loss outweighs the economic gain, the superiority of the Parsons blading reaches its limit.

Under normal conditions this appears only to the high-pressure element. In the middle and low-pressure elements the volume of the expanded steam is so great and the blades are so long that the superiority of the Parsons blading is established. But as the high-pressure part of a purely reaction turbine occupies a very large portion of its total length, while the actual service rendered by it is very small compared to the total output, European builders of Parsons turbines are replacing the high-pressure reaction part by a single-stage wheel with two or three rows of blades. Yet they contend that this "combination type" is preferably adopted only for special services, and that its usefulness depends upon the plant output, steam pressure, speed and a variety of other conditions. They claim that for large units of several thousand kilowatts, the employment of a single stage wheel carries with it no advantages in heat economy. This is be-

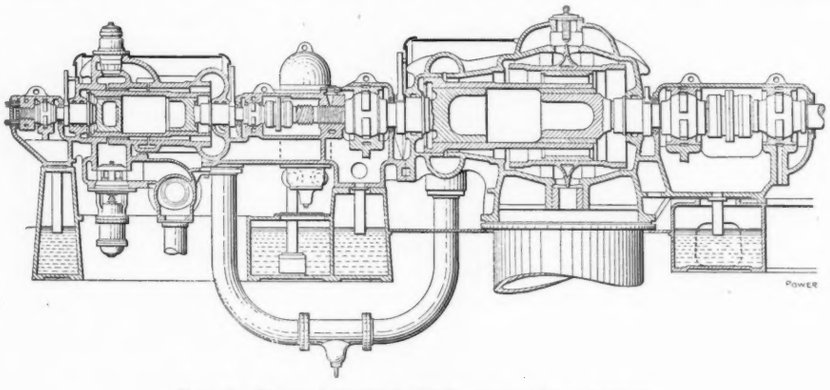


FIG. 2. PURE PARSONS TYPE WITH TWO DRUMS

cause the great mass of steam, even at high pressures, occupies so large a volume that the advantage of the Parsons blading surpasses all others, even in the high-pressure part.

Fig. 1 shows a Parsons turbine with one drum, and Fig. 2 the same type with two drums, which are connected by a

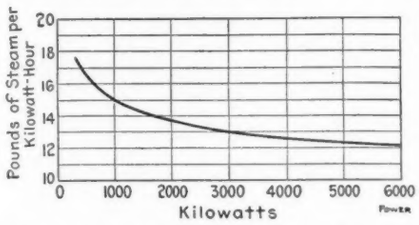


FIG. 4. STEAM CONSUMPTION OF COMBINATION TYPE

movable coupling. The latter is built for capacities up to about 5000 kilowatts the division in two parts being made in order to reduce the distance between bearings. The combination type as built by Brown, Boveri & Co. and shown in Fig. 3 is more representative of modern tendencies. The idea was to combine all the well known and tried constructive advantages of the pure reaction turbine into one of short length, low cost of manufacture, and small bulk, advantages which attend the employment of a single-

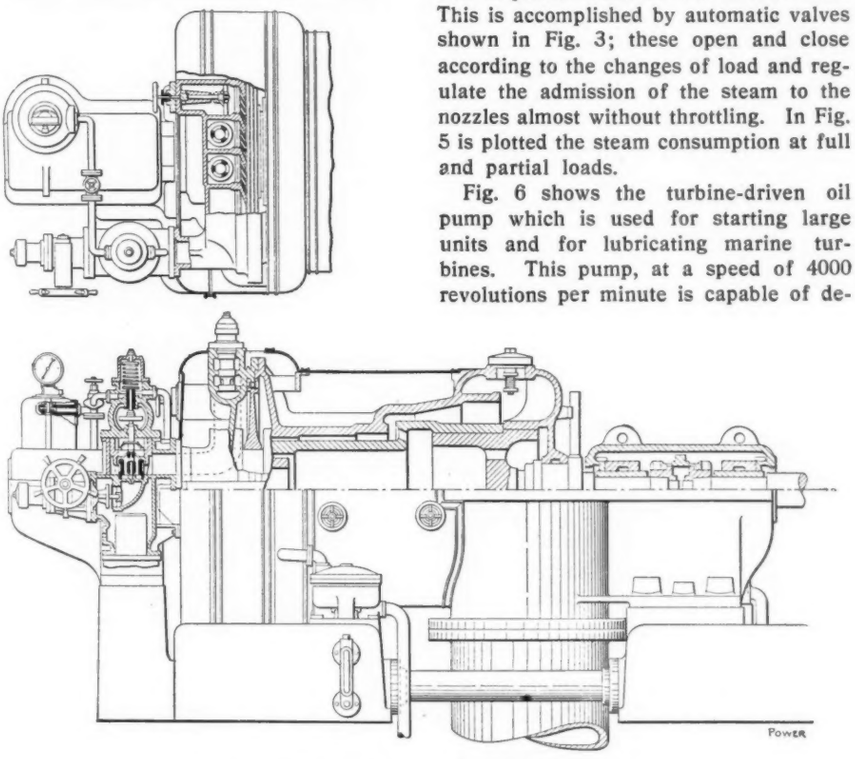


FIG. 3. BROWN-BOVERI COMBINATION TYPE

stage wheel. The latter is mounted on the front of the drum and constitutes a rigid runner, with a short distance between the bearings and ample play at all places, whereby friction between the runner and the cylinder through bending, or vibration at critical speeds is rendered impossible.

This, next to the superior economy, the makers claim, is the great advantage of the "combined" Parsons type over those systems which have only impulse wheels, and which employ a comparatively thin shaft and small clearance in order to keep the leakage losses within reasonable limits. They contend that in combination with a reaction turbine, the disadvantages of the impulse wheel are eliminated and its advantages fully secured. Having to transform only a small fraction of the total energy, the wheel works with moderate steam velocities, whereby undue wear of the runner is avoided and a reasonable efficiency is obtained, there being no leakage loss when a single impulse wheel is employed. Moreover, the combination turbine can be built so short that the gain in space makes it possible to design the reaction part for the most favorable utilization of the steam and to make a turbine whose economy is sometimes superior even to the pure Parson's type. The steam consumption which is attained with this type at normal loads with average steam pressure and vacuum is shown in Fig. 4.

Special care has been taken to improve the system of regulation so as to obtain the best possible steam consumption at partial loads as well as full load. This is accomplished by automatic valves shown in Fig. 3; these open and close according to the changes of load and regulate the admission of the steam to the nozzles almost without throttling. In Fig. 5 is plotted the steam consumption at full and partial loads.

Fig. 6 shows the turbine-driven oil pump which is used for starting large units and for lubricating marine turbines. This pump, at a speed of 4000 revolutions per minute is capable of delivering 52.8 gallons of oil per minute at 22 pounds pressure. It is driven directly by an impulse wheel having two rows of blades.

Among the special claims of the Brown, Boveri & Co., are small wear and constant steam consumption for this type of turbine. In order to secure lasting economy not only must the efficiency of the turbine be high, but it must not be reduced by wear during operation. When attempting to build steam turbines with

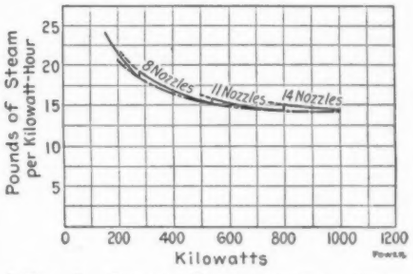


FIG. 5. STEAM CONSUMPTION WITH NOZZLE REGULATION

only a single stage, manufacturers often overlook the fact that for the energy transmitted per unit of blade surface there is a fixed limit which cannot be exceeded without working harm to the machine. It is, therefore, objectionable to assume too small a working surface as compared to the amount of convertible energy, just as it is bad practice to make bearing surfaces and other parts exposed to friction too small and out of proportion to the pressure and velocity. The reduction of turbine proportions by adopting excessive blade speeds with a view to reducing the cost of construction is always accompanied by a corresponding reduction of the total working surface of the runners, whereby the limit is often reached if not exceeded. The inevitable result is a perodical replacing of the runners, when the increasing steam consumption becomes objectionable. By the employment of surface condensers which deliver clean steam to the turbine this drawback is partly nullified.

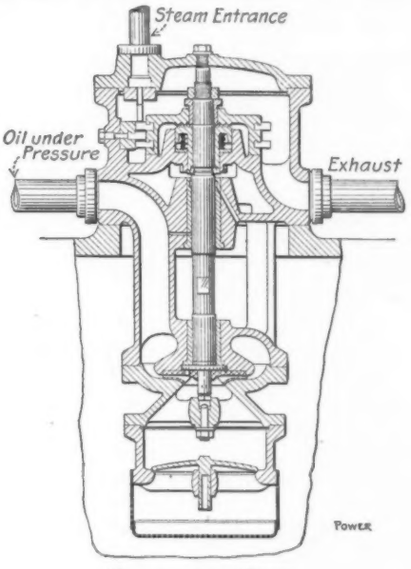


FIG. 6. OIL PUMP

Fig. 7 shows a comparison between the effective blade surface of an impulse tur-

bine having ten stages and of a Parsons turbine of seventy stages. The difference explains, on the one hand, why Brown, Boveri & Co. continue to embody, as far as possible, the Parsons

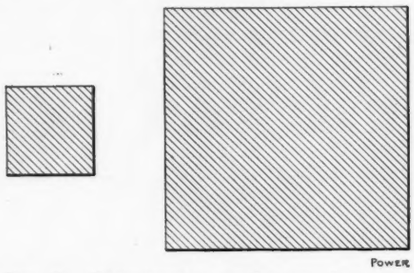


FIG. 7. COMPARISON OF BLADE SURFACE

principle in their new designs, and why, on the other hand, certain types of single-stage pressure turbines, representing the other extreme, are disappearing from the market owing to rapid wear.

Another feature claimed for the Brown, Boveri turbines is that they may be brought up to full load immediately and are practically immune from wide temperature fluctuations. This latter feature is attained by symmetrical proportioning of the cylinder, by the arrangement of the low-pressure balance piston on the exhaust side and by avoiding widely diverging diameters, whereby the equal warming up of all parts is secured, also the high-pressure shaft journal is provided with an internal heating chamber. The blades in the reaction part of the turbine, instead of being merely chiseled into the groove are secured by means of heads, thus providing for expansion at varying temperatures (see Fig. 8). The impulse wheels of the combination type are shown in Fig. 9, the blades being

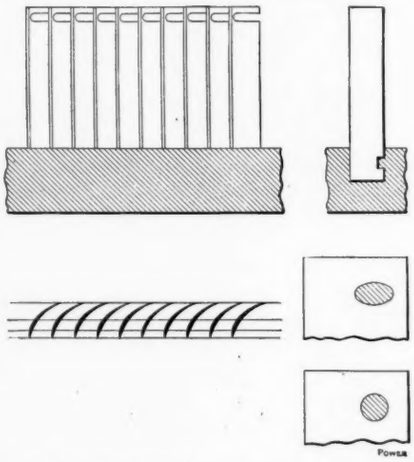


FIG. 8. ATTACHMENT OF BLADES

made of a special bronze, inserted and held in place by distance pieces.

REGULATION

The old type of Parsons turbine with steam-pressure relays gives satisfactory results in practice and has the disadvantage that regulation within certain limits is dependent upon the available steam pressure. Therefore, a new mode of regulation was developed in which the governing piston, instead of being actuated by the steam, is controlled by the oil pressure in the lubrication system. Among the advantages of this system, is that should the lubrication become defective the turbine is brought to a standstill. The governing device consists of two separate parts, shown in Figs. 10 and 11. These are connected only by an oil pipe. The governing device proper (Fig. 10) is mounted on cover *B* of the collar thrust bearing, and comprises the casing *A*, which is divided in two parts surrounded by mantle *C*. Shaft *D* of the governor is driven by a worm gear from

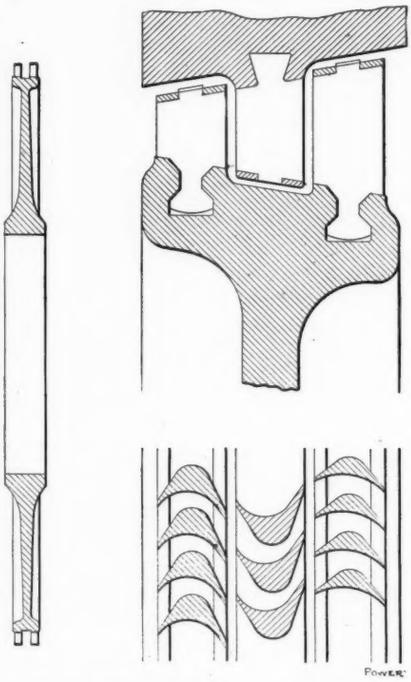


FIG. 9. IMPULSE WHEELS OF IMPULSE TYPE

the turbine shaft *E* and turns within the bearings *F* and *G*, the latter a thrust bearing. On shaft *D* is fastened the safety governor *H* and the main governor *J*, which is connected with socket *K* and revolves within the fixed box *L*. The regulating socket moves in an axial direction on shaft *D*, its position depending upon the position of the governor weights. Box *L* is surrounded by a casing *M*, and, in its lower part, has an annular channel connecting the governing device with the piston *O*, Fig. 11, of the steam-inlet valve by means of the flanged socket *N* and the oil pipe *T*. The piston is fastened to stem *P* of the steam-inlet valve *Q*. From the oil pump *R* a certain quantity of oil under pressure enters through pipe *S* below the oil piston *O* and thence through pipe *T* into the annular space of the casing *M*. In box *L* is a slot connecting with the annular space whose open cross-section depends upon the axial position of the regulating socket *K*. The oil passing through this slot enters through box *L* into the casing *M* and from there drops onto the governor, lubricating its journals and joints as well

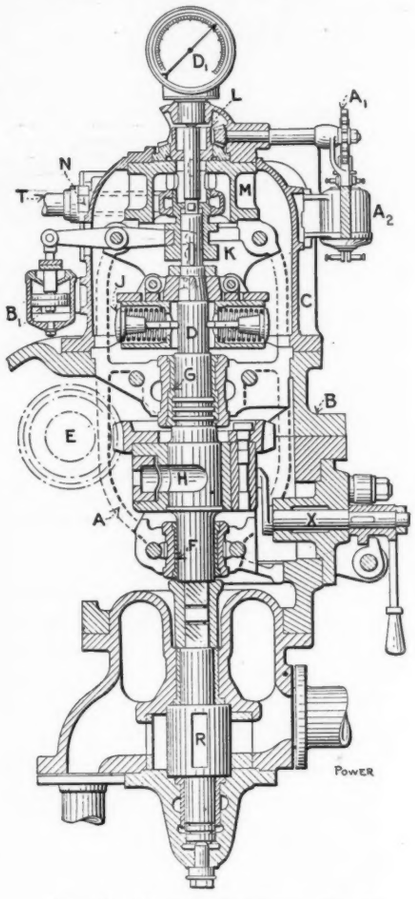


FIG. 10. MAIN GOVERNING DEVICE

as the bearings of shaft *D*, whence it returns to the oil tank.

The action of the oil regulation is as

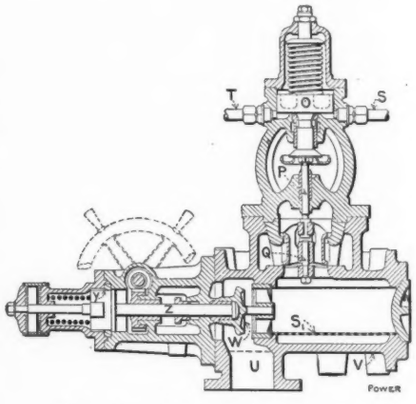


FIG. 11. STEAM-INLET VALVE

follows: Through flange *U* on the valve chest *V*, the steam enters and passes in succession valve *W*, sieve S_1 and valve *Q*. The lift of the steam-inlet valve is determined by the oil pressure under piston *O* acting against the pressure of the spring, regulation being effected by the gover-

nor according to the momentary load. By undulating the edge of socket K the open cross-section of the slot in box L is constantly varied during one rotation of the regulating shaft. This allows a continuous increasing and decreasing flow of oil, and causes a corresponding vibratory motion of the oil piston. The pulsations occur in rapid succession, from 300 to

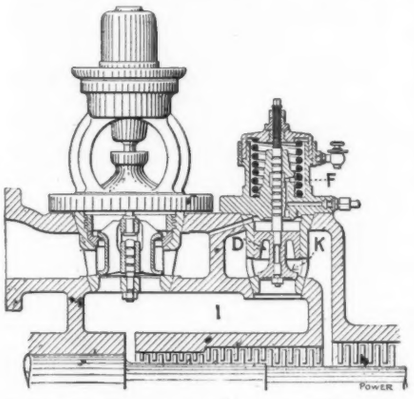


FIG. 12. AUXILIARY VALVE FOR PARSONS' TYPE

700 per minute, and cause only small pressure variations of the steam. Thus both the axial and the rotary motion of the socket are utilized for purposes of regulation, the former for the main and the latter for the secondary effects, the sensitiveness of the governing device being thereby materially increased. In cases of over regulation the cone below piston O serves to increase the open cross-section of the oil bypass, tending to return the piston into its mean oscillating position. In cases of under regulation the same effect is attained by the opposite means.

By turning wheel A_1, the regulating socket is either lifted or lowered, and the open cross-section of the slot is changed and the resulting change of the oil pressure effects a corresponding change in the position of the inlet valve; this produces an increase or decrease in the number of revolutions, providing the load on the turbine remains the same. With a given speed the load can be varied in a like manner, the range of variation being plus or minus 5 per cent. Instead of using wheel A_1, the same operation can be performed from the switchboard by means of a magnetic relay. An adjustable oil brake B_1 takes up sudden shocks which might occur in the regulation. When the speed of the turbine exceeds a certain limit the safety governor H, by means of shaft X and the connecting link, turns the key Y, and the main inlet valve W is closed by the pressure of the spring. The same result can be attained by a hand lever, and in order to reopen the valve again the handwheel must be used.

In order to avoid uneconomical throttling and to utilize all of the available steam pressure at the various loads these turbines are equipped with one or more automatic auxiliary valves. In the pure Parsons type the valve admits steam into a chamber of larger section, (see Fig. 12), whereas, in the Brown-Boveri type it opens another series of nozzles, shown in Fig. 13. In the former type the valve opens if the increasing pressure in space I, together with the pressure of spring F exceeds the force with which the constant boiler pressure acts on piston K. By adjusting spring F the range of operation of the valve can be varied at will. The opening and closing are performed without any evil effect on the regulation, and the automatic valve avoids the necessity of additional hand regulation of the nozzles.

The Brown, Boveri turbogenerators are equipped with four bearings and the shafts of the separate units are connected by a movable coupling. Turbines running at 1500, and less, revolutions per minute are equipped with ball-shaped bushings lined with white metal, and self adjusting. For higher speeds the regular Parsons type of bearing is employed consisting of a number of eccentric boxes which can be so turned as to permit an exact adjustment of the shaft. The small clearance in the box is filled with oil under pressure in order to equalize possible vibrations. The working surfaces are made amply large for the sur-

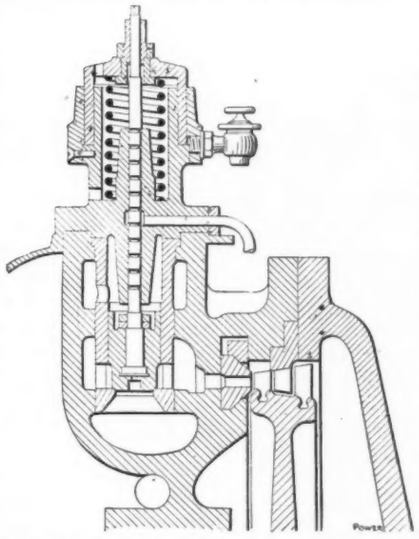


FIG. 13. AUXILIARY VALVE FOR COMBINATION TYPE

face pressure, so that even after several years of continuous operation the bearings show no trace of wear. The only movable part of the Brown, Boveri turbine which is not under the influence of the central lubrication is the steam-inlet valve. Owing to its vertical position, however, this is subjected to little wear. Considering the low class of attendance with which some plants in foreign countries have to reckon, and in view of the fact that, as a rule, they are far from repair shops and have to guard against sudden breakdowns, it is obvious that reliability is a decisive factor, enabling one to reduce the number of reserve units to a minimum, and also to keep the number of interchangeable parts relatively small.

The employment of the Parsons blading and of drums instead of thin shafts, whereby the operating speed is kept far below the critical speed, does away with the necessity for internal guides and packing boxes, which might also necessitate the introduction of lubricants into the turbine. Likewise, the employment of labyrinth packing permits free play of the shaft in an axial direction and avoids the use of lubricants in the boxes. Special care has been taken by the builders to provide accessibility to the internal parts. By lifting the upper half of the cylinder the whole drum is exposed and the guides and runners can be inspected without having to remove separating walls. The bearings also can be easily uncovered. All movable parts of the regulating system are contained in casing A, and the mantle C can be removed by unscrewing a few bolts. The oil pump which is attached to the lower end of the regulating shaft can be taken out and inspected by opening the cover below it, and without having to dismount the governing device.

The World's Largest Crane

According to Consul J. N. McCunn, of Glasgow, there has been erected at Govan, on the River Clyde, for the Fairfield shipyards, the largest crane in existence. The official trials of this mammoth appliance have been satisfactory and it stands in bold relief on the River Clyde, where a number of the most powerful cranes in the world had previously been erected.

The jibhead of the crane is of the hammer-head type, built on the cantilever principle, and stands 160 feet above high-water level, or to rail level 169 feet. The jib, with a total length of 270 feet, extends 169½ feet outward from the center and can be utilized within every point of a circle 336 feet in diameter. The motors for operating the gear vary from 60 to 90 horsepower, and are situated in the machinery house at the rear end of the crane, the test load of which is 250 tons.

The crane, on slow gear, can elevate 200 tons extended 75 feet along the jib, and on quick gear it can manipulate a load of 100 tons at 133 feet. The maximum load of 200 tons can be lifted from 30 feet below wharf level to 140 feet above, a total of 170 feet. The three controlling brakes are worked by magnetic, mechanical and hydraulic action. The stability of the structure of the crane depends on four huge steel cylinders, one under each corner of the tower. These great tubes, 15 feet in diameter at their base, are filled with concrete and sunk 74 feet below ground.

Gas Power Department

Everything worth while in the gas engine and producer industry will be treated here in a way that can be of use to practical men

Intake Manifolds for Multicylinder Engines

By John S. Leese

Discussing Mr. Hall's engine in the April 25 number, B. M. Howze gave a sketch of a symmetrical intake manifold,

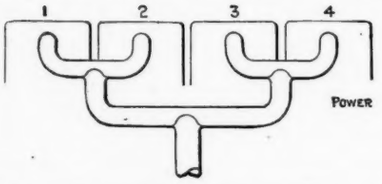


Fig. 1. Symmetrical Intake Manifold Given by Mr. Howze

reproduced here as Fig. 1, and said that the intake piping should be arranged as shown in that sketch.

Although from the point of view of mechanical symmetry Mr. Howze's piping is perfection, I should like to point out that in order to get the mixture to the cylinders, at least five right-angle turns in various planes have to be passed and six if the carbureter flange faces

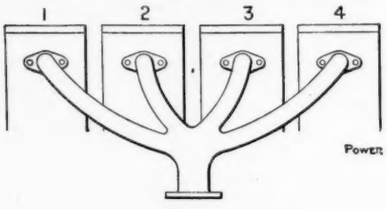


Fig. 2

horizontally. I believe that it would be better on all counts if builders would go to the trouble of either designing their piping as shown in Fig. 2, with easy sweeps from the carbureter to the cylinders and suitably proportioned to insure an equal supply of gas to all cylinders, or as shown in Fig. 3, in which case the equality of supply could be assured either by increasing the diameter of the pipe, as indicated in the sketch, or by casting or fitting two bores in the manifold, one supplying two cylinders, one on the right-hand and the other on the left-hand side.

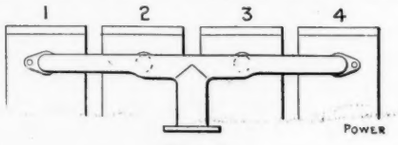


Fig. 3

Some makers of multicylinder gas engines have got over the unequal-supply difficulty when the gas is supplied at one end of a manifold by casting their manifolds as shown in Fig. 4. The order of firing is 1, 3, 4, 2, so that Nos. 1 and 4 and Nos. 2 and 3 do not require their mixture consecutively. The light shading in the flange orifices is intended to convey the impression that that particular flange is fed from the passage on that side; that is, from the side of the light shading.

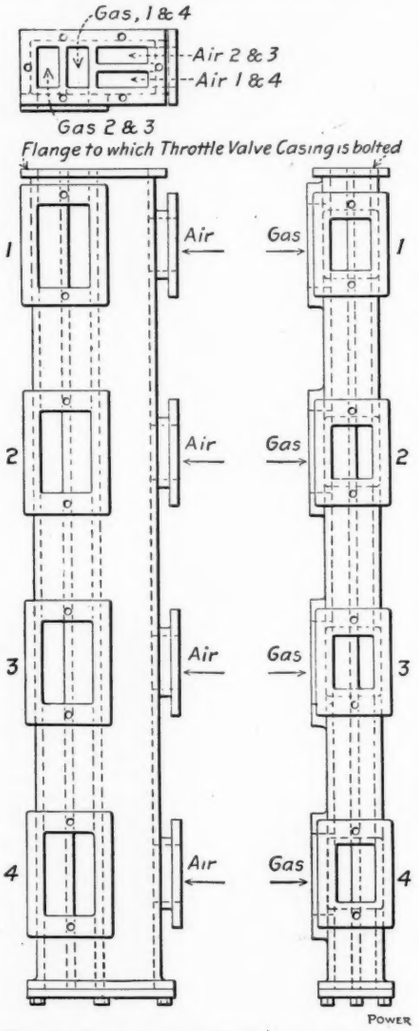


Fig. 4. Partitioned Manifold for Uniform Distribution

Fig. 5 is a set of accurate tracings of indicator diagrams taken from a four-cylinder vertical engine fed by a manifold like that in Fig. 4 and there can be no cause for complaint about their nonuniformity. All valve timings, spark adjustments, etc., are exactly alike on this engine and the cylinder heads and combustion chambers are machined all over so that equal volumes are assured.

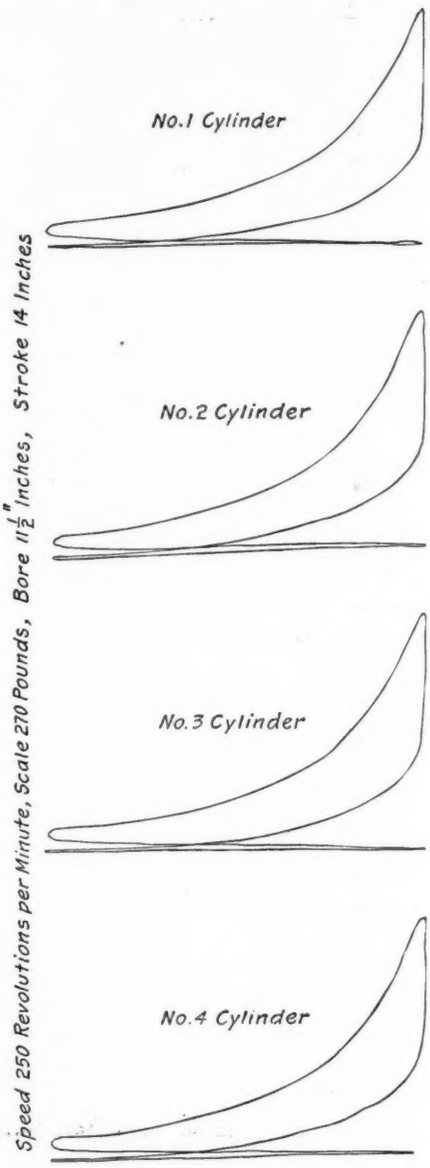

No.1 Cylinder
No.2 Cylinder
No.3 Cylinder
No.4 Cylinder
Speed 250 Revolutions per Minute, Scale 270 Pounds, Bore 11/2" Inches, Stroke 14 Inches

Fig. 5. Diagrams from Engine Equipped with the Manifold in Fig. 4

Correcting Back Firing and Fuel Waste in a Large Producer Gas Engine Plant*

By John G. Callan

A short time ago the writer, with some associates, had occasion to test a large producer-gas engine plant in order to determine whether or not the plant met guarantees as to average and maximum output and fuel efficiency, and every effort was made to put the machinery in the best of condition and to obtain the best possible performance. It is not the purpose of this paper to report the entire test, which occupied the greater part of a month, but rather to point out some specific items wherein it was possible to improve performance, and to briefly analyze the more important of these. Since, in spite of best endeavors, it was not possible to bring the apparatus up to guarantee I omit any specific references by which the plant would be readily identified.

The installation consisted of single tandem double-acting producer-gas engines with 33x48-inch cylinders, driving three-phase 25-cycle alternators at 107 revolutions per minute. The alternators operated in parallel and delivered power to an industrial plant furnishing a substantially steady load, and to some other minor users.

Gas was furnished by producers of a well known type. From their individual wet scrubbers the gas passed through a common dry scrubber to a 30,000 cubic foot holder and thence to the distributing main leading to the engines. The fuel was lignite of about 7600 B.t.u., containing about 34 per cent. moisture and 8 per cent. ash. The gas averaged about 105 B.t.u., high thermal value. In making our tests the mill load was adjusted to suit the engine output and there was always available as much load as the engines could carry.

The plant had been installed by the manufacturers and shortly after its installation the designer of the engines had spent a great deal of time in bringing it up to the best possible performance. Subsequent to this, the operating engineer of the station had continued running the plant along the lines which had been fixed upon by the designer and he obtained slightly better results from the engines, and also somewhat improved producer performance. The results were still very far from satisfactory, however.

We found that the engines had given much trouble with back-firing and some with premature ignition. The back-firing had been so serious that it had been deemed necessary to put throttles in the air lines and cut down the air supply to a point below that at which the rate of propagation of the flame in the mixture was a maximum. As is well known, this expedient, though wasteful of gas, is usually effective in stopping back-firing and it was so in this case.

We were told that the designer of the engines directed that they should be adjusted to give "round-top" diagrams and indicator diagrams which we took showed that these instructions had been observed. This shape of diagram is obtained by timing the ignition so that it is not early enough to bring about substantially complete combustion during the period of very slight motion near the dead center.* The exact timing of ignition to give this or any other shape of diagram naturally depends on many factors, the principal ones being compression; composition and homogeneity of mixture; shape of combustion space and location of spark plugs; temperature [?] and character of spark. The ignition points of the different engine cylinders in the plant under discussion differed somewhat and had been determined empirically as giving the desired diagram with the rich mixture deemed necessary to prevent back-firing.

This practice led, as late ignition is likely to do, to a magnification of the unavoidable differences between successive diagrams, so that a "card" consisting of twenty successive diagrams with one unchanged governor and mixture setting showed a very large range of contours. We were assured by the attendants, however, that if the mixture giving best maximum diagram were employed, the back-firing would recommence and in time become prohibitive. Tentative experiments seemed to confirm this and it therefore became necessary to determine the reason for this back-firing.

Back-firing is most likely to occur from ignition of the incoming combustible mixture at the inlet valve. In a double-acting engine it may also be caused by leakage of hot gases from the explosion in one end past the rings and into the other end where the suction stroke has just been completed. It may also occur from a lingering flame in an indicator fitting or from red-hot carbon or extremely hot metal parts so placed as to pocket gas between two heated surfaces.

If the back-firing is due to escape of flame past the piston rings it can occur in only one of the ends of a given cylinder on a four-stroke double-acting engine. For instance, if the cam setting is such that combustion is occurring in the crank end just as suction is finished in the corresponding head end, there may be preignition from this source in that head end but, since the cycle is never reversed, it can never occur in that crank end. Since one of the most obstinate cases of back-firing of which the writer had known was due to this cause the matter was carefully investigated. It was found that preignition occurred in the crank ends and head ends indiscriminately, so that blowing through the rings was certainly not the only source even if it was an occasional one.

The indicator fittings not already so made were changed to a type which closed off practically flush with the inner surface of the cylinder wall and it was at first thought that this effected an improvement, but back-firing developed again, proving that it was merely chance which caused its diminution when the new fittings were put on. This led to the inevitable conclusion that the trouble was ignition of the incoming gas either by the outgoing exhaust or by heated parts of the cylinder, or both.

The design of the engine differed from that of most American tandem double-acting gas engines in that the valves occupied a valve chamber connected by a relatively narrow neck with the main clearance of the cylinder. The exhaust valve was in the bottom and the inlet valve in the top of this chamber and they were separated from each other by a distance of only about ten inches.

The valve setting was such that the inlet opened before the exhaust closed. The amount of lap was different on different cylinders, due to slight wear of the cams and rollers, and it could be controlled to some extent by adjusting the amount of clearance between the valve rocker-arms and the stems, but with no normal adjustment which did not entail serious shock was there a complete closure of the exhaust port before the inlet valve opened. This suggested the idea that the slight back pressure presumably existing in the cylinders might force a little of the hot exhaust gas past the slightly opened inlet valve and ignite the mixture. This seemed highly improbable, however, on account of the cooling action on the gases which would result from intimate contact with the water-cooled inlet-valve seat and the valve which had just risen from it.

By diagrams and other means we endeavored to determine whether the back-firing took place at the end of the stroke or at some intermediate time and concluded that it was at the beginning, and for the time we fell back on the hypothesis that the heated valve chamber caused ignition of the combustible mixture during the early part of the inlet stroke.

Finally we took stop diagrams with a light spring and full diagrams with the ordinary spring, but with the back-lash in the indicator motion. These showed unforeseen conditions during exhaust and led to the true solution. It was found that the pressure in the cylinder immediately after the opening of the exhaust valve was above atmospheric, as might

*Abstract of a paper presented before the Congress of Technology at the fiftieth anniversary of the granting of the charter of the Massachusetts Institute of Technology.

*A more rational method, which is usually employed by experienced engineers, is to use a rather "lean" mixture and increased advance of ignition timing.—Editor.

be expected, and that it remained there for a certain fraction of the exhaust stroke. For the remainder of the exhaust stroke, however, the proportion varying with load and cylinder from the last two-thirds to the last half of the exhaust stroke, there was a very slight vacuum in the cylinder instead of the positive back pressure which had been expected. This was found to be due to the wave set up in the long straight exhaust pipe by the first vigorous puff at release.

From this it immediately became clear that on the opening of the inlet valve explosive mixture began at once to enter the valve chamber, even though the piston had not yet finished its exhaust stroke, and that this inflow became more and more vigorous as the valve opened farther, the incoming mixture mingling with the outgoing exhaust gases and in part passing out with them through the exhaust port. This explanation of the back-firing was entirely rational. We did not have to assume that the exhaust gases were hot enough to pass through a slightly open, relatively cool port and still retain the temperature required to ignite explosive mixture, nor did we have to assume walls so hot that a rapidly whirling and eddying blast of incoming mixture impinging upon them was thereby ignited.

It was then assumed that a large number of incipient ignitions took place which did not propagate fast enough backward along the incoming gas stream to reach the mixing chamber and were blown out as the velocity of induction increased. Accepting this hypothesis and also recognizing the fact that a perfect mixture fires more easily and propagates flame faster than others, it was apparent why a rich slow-burning mixture prevented most of the trouble.

It was all along recognized that the use of an unduly rich mixture besides being wasteful was objectionable because it increased the luminosity of the flame and hence the radiation, besides coating the interior of the cylinder with a carbon deposit which tended to reduce the efficiency of the water jacket and to increase the skin temperature of the interior of the valve chamber.

While this matter was being analytically investigated a series of diagrams had been taken running with various mixtures and ignition settings and it had been decided that on account of the extremely heavy reciprocating parts the maximum stresses on the journals would not be greater with pointed than with round-top diagrams, since apparently the largest component in maximum journal pressure was that due to inertia rather than that due to the explosion. This last conclusion was borne out by the fact that the bearings ran much hotter on no load than on full load.

On account of the apprehensions of the station attendants these experimental settings were not at first maintained very long, but since they bore out the conclusions just mentioned, we finally changed the operation of all the engines as to both the mixture and the ignition settings. The mixture was adjusted for a slight excess of air over theoretical requirements and the ignition was timed materially earlier, producing a pointed rather than a round-top diagram and materially reducing the temperature of the gas at the moment of release when the explosive mixture mingled with it. After these changes were made the marked improvement in operation became so apparent as to convert even the more skeptical of the station men. Back-firing was not wholly eliminated, occurring occasionally in all cylinders and particularly in certain ones, despite the changes, but the improvement was distinctly greater than we had expected. The changes also enabled us to increase the engine output and to materially cut down the amount of gas used per kilowatt-hour. The reduction in fuel consumption was so marked that it was not merely observable by the methods of the test but was noticed by the producer men during a period when the engines were carrying considerably more load than was previously customary.

It was interesting to note that some analyses of the exhaust gas showed that if samples were taken as usual from a point a few feet below the top of the exhaust pipe, the analysis indicated a rather large excess of air in the mixture at a time when it was practically certain that such an excess did not exist. This might easily have misled previous observers and was, of course, due to the regurgitation of air into the exhaust pipe during the recession of the wave set up in the pipe by the "puff" occurring at release, as well as the loss of combustible mixture into the exhaust.

Gas Producer Investigations by the United States Bureau of Mines

At the Pittsburg fuel-testing station of the Bureau of Mines an experimental gas producer has been installed for the purpose of studying the processes which go on in producers and to investigate the feasibility of slagging the ash by the addition of a flux so as to remove the non-combustibles in the form of liquid slag.

The outfit includes a small steam boiler and a positive blower, by means of which it can be operated as a pressure producer.

The blast is introduced through water-cooled tuyeres located near the bottom of the generator; steam is admitted through separate tuyeres which are located in a plane one foot above the air tuyeres; fuel is charged through a hopper at the top, and at the bottom of the generator provision is made for the removal of liquid slag as it forms.

Tests to investigate the effect of slagging the ash, both as to economy and deterioration of the producer lining, are now in progress. Subsequent tests are planned to study the effect of varying the fuel-bed thickness, the ratio of air to steam, the rate of combustion, the size of coal and the preheating of the air. It is considered desirable to make these tests first with as nearly an elementary fuel as possible; therefore, coke is being used. Other fuels will be used later.

In tests already made, it has been found that the ash can be made to slag readily and that the slag will run freely from the producer. The best results, thus far, have been obtained when approximately 15 pounds of limestone were charged per 100 pounds of coke, but of course this ratio will vary according to the chemical analysis of the coke, the ash and the limestone. In one test of over 75 hours' duration, the slag was tapped off about once an hour with very satisfactory results as far as the slag was concerned, but by the end of this run the generator lining had suffered severe deterioration. The temperatures necessary for the formation of liquid slag are very favorable for the production of gas and in the tests already made the CO has generally been above 30 per cent., while the CO_2 has been well under 2 per cent. These percentages, however, were obtained with air alone, no steam being used.

The high rate of combustion also increases very materially the capacity of the producer; frequently, 2000 to 2500 cubic feet of gas per square foot of fuel bed per hour have been produced, having a heat value of about 115 B.t.u. per cubic foot, thus giving an output of approximately 25 horsepower per square foot of fuel-bed area. Up to the time of the recent A. S. M. E. meeting in Pittsburg, no attempt had been made to operate the producer at its maximum rate.

Fuel briquets from street rubbish, states a contemporary, have been experimented with at Amsterdam, Holland. Hitherto the rubbish has been assorted and the paper, rags, metals and glass sold to dealers. The city authorities are now considering converting the street sweepings into combustible briquets for heating boilers. In Southwark, London, the refuse is crushed to a powder and sold as manure. At St. Ouen, France, the powder thus made, with the addition of combustible substances, is converted into a cheap fuel. At Amsterdam, experiments were made in combining the pulverized rubbish with coal tar from the gas works and pressing into briquets; the results are said to have been successful. The quantity of material available is about 140,000 tons yearly

Annual Convention A.I.E.E. at Chicago

The twenty-eighth annual convention of the Institute, held in Chicago, was opened on Tuesday morning, June 27, with several hundred delegates actually in the hall. After the usual preliminaries, President D. C. Jackson delivered his address in which he departed widely from the beaten track of presidential addresses to impress upon his hearers their ethical obligation to society at large in the direction of properly controlling the potent factors in civilization which they themselves have been the means of creating. That part of his homily was particularly graceful and well founded and it is to be regretted that he almost spoiled the effect of it by winding up his address with a barefaced advocacy of the cause of public-service corporations and an exhortation to the engineers to stir themselves with a view to educating the public into "recognition" of the "rights" of such corporations.

President-elect Gano Dunn was then introduced and acknowledged his introduction in a most modest but none the less forceful acceptance of the responsibilities as well as the honors of the office to which he has been elected.

Power-limiting Reactances in Large Stations

The first paper read at the convention was one by R. F. Schuchardt and E. O. Schweitzer, of the Commonwealth (Chicago) Edison Company, on the use of power-limiting reactances with large turbo-alternators. The troubles of the early alternating-current stations containing slow-speed alternators driven by reciprocating engines are quite well known, and were comparatively simple in the light of modern practice. When high-speed turbo-alternators were introduced, however, new and serious troubles developed which indicated that these units had characteristics quite different from those of the older ones. The experience of the Chicago Edison Company during the past eight years has shown an increasing severity in disturbances and line troubles with the increase in station-generator capacity.

The four original 5000-kilowatt alternators at Fisk street had their neutrals grounded solidly. These were all 9000-volt machines running at 500 revolutions per minute. When a fifth unit was installed, of larger capacity and running at higher speed, it was found that when the neutral of this unit was connected to the ground, a heavy cross-current flowed between it and the other units and a resistance of about 2½ ohms had to be installed in the neutral connection. All additional units were also provided with neutral resistances and later the solid neutral ground connections of the four original units were removed.

Disturbances were, however, still sufficiently severe to be seriously troublesome and the system was therefore divided into sections so that when a fault occurred it could be limited to the section in which it was located. Even with this precaution severe disturbances occur, some of which develop in the generator armatures themselves. In the four years from 1906 to 1909 inclusive there were seven generator burnouts and in all of these cases the projecting ends of the armature windings were torn loose and the windings wrecked. This led to more rigid construction of the generators and the use of a new form of armature winding with a stronger arrangement of end projections and with one coil per slot instead of two. This improvement was efficacious but with severe short-circuits the circuit-breaker switches gave considerable trouble and in some instances failed. This showed the necessity for limiting, by means of added reactances, the current which can flow into a defective circuit. The transformers were rewound so as to make their internal reactance higher and new generating units were also constructed with higher internal reactance. Additional reactances, external to the apparatus mentioned, were provided in series with the primary leads of the transformers, which operate at 9000 volts. These have been in service nearly two years, during which time the transformers have withstood a number of short-circuits of a kind which had previously wrecked them.

In the case of the generators the installation of reactances was a far more serious problem and in view of the large investment required, as well as in order to proceed more intelligently, it was decided to determine by exhaustive tests the exact effects of added reactances in the circuit. For this purpose one of the 12,000-kilowatt units at the Fisk Street station was used. Tests were made with this unit to determine the instantaneous short-circuit current of the generator without any external reactance; the instantaneous short-circuit current with an external reactance of 4 per cent.; the instantaneous short-circuit current with an external reactance of 6 per cent.; the duration of transient phenomena incident to the short-circuits; the effect of the short-circuit currents on the generator; the behavior of the reactance coils, and the effect of these coils on the stability of the system.

A set of three reactance coils, one for each phase, was used. Each coil had 76 turns of cable wound on a hollow concrete core about three feet in diameter. The cable had a cross-section of 1,000,000 circular mils. The impedance of each coil at 25 cycles measured 0.425 of an ohm and the resistance measured 0.0075 of an ohm. The tests were made by short-circuiting the generator while it was running at full speed and with the neutral connection solidly grounded except in one or two instances, when a resistance of 2½ ohms was inserted in the neutral connection.

With the generator excited to give 3000 volts the maximum current obtained without any reactance in circuit was 9800 amperes, and at 4000 volts it went up to 13,000 amperes. Assuming this proportionality to hold all the way up to normal voltage, the maximum current at the normal pressure of 9000 volts would be about 29,000 amperes, or 27 times the full-load current of the machine. With the 4 per cent. reactance in circuit, which would take up 208 volts at 25 cycles and full-load current, the current values obtained were such as to indicate that at the normal voltage of 9000 the short-circuit current would have been about 18,000 amperes, and with an external reactance of 6 per cent., which would take up 328 volts with full-load current, the short-circuit current at 9000 volts was 15,800 amperes or 14½ times the full-load current.

Extensive precautions were made to determine the effect upon the generator and the reactance coils of the short-circuit currents, but there were apparently none; no displacement or indications of damage or distortion could be detected.

The tests indicate that the instantaneous short-circuit current of the generator on which they were made is not as high as has been thought but they also indicate that this current, on account of its comparatively high power factor, can produce severe stresses on the generator and the oil switches. They also indicate that the use of such reactances will tend to make the operation of the system as a whole more stable and therefore to increase the liability of service.

When the tests described in the paper of Messrs. Schuchardt and Schweitzer were made, the behavior of the oil circuit-breakers employed was also watched very carefully and in a short paper by E. B. Merriam the results of the tests on the circuit-breakers were described.

Whenever an electrical circuit carrying a large amount of energy is open under oil, gases are generated and these, of course, expand and tend to force the oil out of the containing vessel. Oil switches have been blown up and totally wrecked by the gases thus formed by the arc between their contacts, but the switches used in these tests did not show any distress from this cause. They were the ordinary type of oil circuit-breakers operated by solenoids, but there had been

TABLE 2. COST OF OPERATION AND MAINTENANCE OF WESTVILLE POWER STATION FOR 1910

		Items	January		February		March		April		May		June		July		August		September		October		November		December		Year	
			Total	Cents per kw-hr.	Total	Cents per kw-hr.	Total	Cents per kw-hr.	Total	Cents per kw-hr.	Total	Cents per kw-hr.	Total	Cents per kw-hr.	Total	Cents per kw-hr.	Total	Cents per kw-hr.	Total	Cents per kw-hr.	Total	Cents per kw-hr.	Total	Cents per kw-hr.	Total	Cents per kw-hr.	Total	Cent per kw-hr.
OPERATION	Labor	Boiler room	1,069 73	0 050	1,073 82	0 058	1,153.75	0 053	1,289 59	0 064	1,189.43	0 056	1,187.22	0.055	1,314.55	0 047	1,386.02	0 045	1,319.78	0 051	1,239.95	0 056	1,224 86	0 052	1,293.66	0.047	14,742.36	0.052
		Turbine	803 59	0 038	806.95	0 043	771.83	0 036	828 21	0.041	854 00	0 040	795 88	0 037	857.18	0 031	855.69	0 028	866.82	0 033	866 06	0 039	861 18	0.036	843.42	0.031	10,010.81	0 035
		Electrical	133 69	0 006	135 18	0 007	131.53	0 006	140.37	0 007	142 71	0 007	138 75	0.006	141 89	0 005	138 10	0 004	135.46	0 005	139.48	0 006	140 89	0.006	142 97	0 005	1,661.02	0 006
		Supervision janitors and watchmen	431 09	0 020	388 56	0 021	371 13	0 017	188 13	0.009	169 83	0 008	164.15	0 007	181.20	0.007	171.67	0 006	176 60	0 007	179 14	0.008	166.53	0.007	168.20	0.006	2,756.23	0.010
		Total operating labor	2,438 10	0 114	2,404 51	0 129	2,428 24	0 112	2,446 30	0 121	2,355 97	0.111	2,286.00	0.105	2,494 82	0 090	2,551 48	0 083	2,498 66	0 096	2,424 63	0 109	2,393.46	0 101	2,448.25	0 089	29,170.42	0.103
	Material	Coal	7,725 38	0 363	7,049 28	0 378	7,769.57	0 358	7,169 62	0.353	7,575 21	0 358	8,262 96	0 381	9,849 62	0 354	10,578.06	0 343	9,592 80	0.370	7,908 66	0.355	8,770 38	0.368	10,463.82	0.379	102,715.31	0 363
		Water	41 67	0 002	41 67	0 002	41 68	0 002	41 67	0.002	41.66	0 002	41 65	0 002	41.67	0.001	41.68	0.001	41.68	0.002	41.66	0.002	41 66	0.002	41.65	0.002	500.00	0.002
		Lubricants									40.72	0.002	38 27	0 002	47.37	0.002	101.21	0 003	25.74	0.001	35 63	0 001	40 05	0 001	75.92	0.003		
		Misc. material	204 62	0 010	121 51	0 007	234 71	0 011	137 25	0 007	75.38	0 004	78 33	0.004	147.62	0 005	131 95	0 004	167.39	0 007	169.71	0 008	156.81	0.007	208.25	0 007	2,238.44	0.007
		Misc. charges	123.10	0 005	120 88	0.006	112 40	0 005	116 80	0.005	144.48	0 007	172.80	0 008	124 60	0.004	213.98	0 007	230 77	0 009	127.00	0 006	117 33	0.005	96.35	0.003	1,700.49	0.006
		Total operating material	8,094 72	0 380	7,333 34	0.393	8,158 36	0 376	7,465 34	0 367	7,877.45	0.373	8,594 01	0 397	10,210 88	0.366	11,066.88	0 358	10,058.38	0 389	8,282 66	0 372	9,126.23	0.383	10,885.99	0.394	107,154.24	0.378
	Total operation		10,532 82	0 494	9,737.85	0 522	10,586.60	0 488	9,911 84	0 488	10,233.42	0.484	10,880 01	0.502	12,705 70	0.456	13,618.36	0.441	12,557.04	0 485	10,707.29	0 481	11,519.69	0.484	13,334.24	0.483	136,324.66	0.481
MAINTENANCE	Labor	Building	13 04	0 001	4 91	0 000	4 41	0 000	67 21	0.003	45.20	0 002	31.89	0.001	8 08	0+000	14 02	0.000	58.29	0 002	20 54	0 001	37.55	0.002	21.15	0.001	326.29	0.001
		Boiler room	79 67	0 004	148 68	0.008	191 89	0 009	220 67	0.011	159 36	0.008	82 21	0 004	104.35	0.004	127.66	0 004	129.76	0 005	97 50	0 004	121.98	0.005	86.71	0.003	1,550.44	0.005
		Turbine	32 13	0 001	48 48	0 003	118 85	0.005	30 66	0.001	29.64	0.001	97.10	0 004	52.75	0.002	10.96	0.000	22 57	0 001	51.40	0.002	47.35	0.002	294.22	0.011	836.11	0.003
		Auxiliary apparatus	39 74	0 002	43 22	0 003	33 71	0.002	31 44	0.001	33 22	0.002	189.25	0 009	84.34	0.003	174.36	0.006	49.20	0.002	22.06	0.001	134.89	0.006	8.74	0.000	844.17	0.003
		Electrical	0 56	0.000	4 95	0 000	13 57	0 001	15 92	0.001			15 46	0 001	75 56	0.003	26 21	0.001	21 53	0 001	4.47	0 000	10.15	0.000	6.92	0.000	195.30	0.001
		Piping	35 74	0 001	39 47	0 002	48 03	0 002	73 02	0 004	72 23	0.003	70 83	0 003	66 10	0 002	75 10	0 003	52.34	0 002	57 25	0 003	57.07	0.002	44.76	0.002	691.94	0.002
		Miscellaneous	36 49	0.002					13 68	0.001	34.11	0.002	65 84	0 003					20 66	0 001	16 52	0 001					187.30	0.001
		Total maintenance labor	237 37	0 011	289.71	0 016	410 46	0.019	452 60	0 022	373 76	0.018	552 58	0.025	391.18	0.014	428.31	0 014	354 35	0.014	269.74	0 012	408 99	0.017	462.50	0.017	4,631.55	0.016
	Material	Building	8 26	0 000	3 63	0 000	10 76	0 001	42 01	0 002	44 92	0.002	13.81	0.001	1.74	0.000	1.71	0 000	10 87	0 000			5.17	0.000	3.75	0.000	146.63	0.001
		Boiler room	145.62	0 007	304 04	0.016	249 03	0 012	231 07	0 011	89.60	0.004	196.62	0.009	68.01	0.003	109 73	0 004	48.02	0 006	546 11	0 025	170.24	0.007	235.14	0.009	2,493.23	0.009
		Turbine	3 19	0 000	125 41	0 007	363 53	0 017	440 23	0 022	88 04	0.004	25 15	0 001	24 05	0.001	76 86	0 002	67 58	0.002	361.11	0.016	8.08	0.001	14.29	0.000	1,597.52	0.006
		Auxiliary apparatus	26 35	0 001	144 10	0 008	43 30	0 002	58 26	0 003	67 66	0 003	264.32	0 012	8.78	0.000	1,332.58	0.043	22.69	0.001	28.81	0.001	19.48	0.001	67.36	0.003	2,066.13	0.007
		Electrical	0 56	0.000	0 74	0 000	4.82	0 000			3.12	0.000	83.79	0.004	2,924.12	0.105	0.85	0.000	13.02	0.000	6 74	0.000	0.14	0.000	8.50	0.000	3,016.44	0.011
		Piping	9 96	0.001	21 97	0 001	31.81	0 001	52 29	0 003	12 16	0 001	42.66	0.002	9.74	0.000	10 66	0.000	40.02	0.002	106.49	0.005	24.73	0.001	21.48	0.001	383.97	0.001
		Miscellaneous			52.97	0.003	49.21	0 002	40 67	0 002			87.87	0.004	84.46	0.003									283.88	0.010	599.06	0.002
		Total maintenance material	193.98	0 009	652 86	0 035	752 46	0 035	864.53	0 043	305 50	0 014	714 22	0 033	3,103.34	0.112	1,532.39	0.049	302 20	0.011	1,049.26	0.047	227.84	0.010	634.40	0.023	10,332.98	0.037
	Total maintenance		431 35	0 020	942 57	0 051	1,162 92	0.054	1,317.13	0.065	679 26	0 032	1,266.80	0.058	3,494.52	0 126	1,960 70	0.063	656.55	0 025	1,319.00	0.059	636.83	0.027	1,096.90	0.040	14,964.53	0.053
SUMMARY	Total labor		2,675 47	0 125	2,694.22	0.145	2,838 70	0 131	2,898.90	0.143	2,729.73	0 129	2,838 58	0.130	2,886.00	0 104	2,979.79	0 097	2,853.01	0.110	2,694.37	0.121	2,802.45	0.118	2,910.75	0.106	33,801.97	0.119
	Total material		8,288 70	0 389	7,986.20	0 428	8,970 82	0 411	8,329.87	0.410	8,182.95	0 387	9,308.23	0 430	13,314 22	0.478	12,599.27	0.407	10,360 58	0.400	9,331.92	0.419	9,354.07	0.393	11,520.39	0.417	117,487.22	0.415
	Total labor and material station proper		10,964.17	0 514	10,680 42	0.573	11,749.52	0 542	11,228 77	0.553	10,912.68	0 516	12,146.81	0.560	16,200 22	0.582	15,579.06	0.504	13,213.59	0 510	12,026.29	0.540	12,156.52	0.511	14,431.14	0.523	151,289.19	0.534
	Other items charged to station accounts		143 83	0 007	144 86	0 007	137.83	0.006	192.62	0 009	197 62	0.009	174 49	0.008	189 88	0.007	199.84	0.007	184.06	0.007	182.68	0.008	199.52	0.008	213.37	0.008	2,160.60	0.008
	Total		11,108 00	0 521	10,825 28	0 580	11,887 35	0 548	11,421.39	0.562	11,110 30	0 525	12,321.30	0.568	16,390.10	0 589	15,778.90	0.511	13,397.65	0 517	12,208.97	0.548	12,356.04	0.519	14,644.51	531	153,449.79	0.542
	Net output		2,131,000		1,865,300		2,168,600		2,031,400		2,115,900		2,167,500		2,784,300		3,088,300		2,590,400		2,229,000		2,381,500		2,759,300		28,312,600	
	Lbs. coal per kw-hr		3 311		3 46		3.27		3 223		3.269		3.14		3.16		3.058		3.306		3.168		3.288		3.386		3.246	
	Cost of coal per 2000 lbs		$2 19		$2 19		$2.19		$2.19		$2.19		$2.42		$2 24		$2.24		$2.24		$2.24		$2.24		$2.24		$2.235	

added baffles that divided up the energy due to the expansion of the gases and permitted the gases to escape into the air without throwing out the oil. The stresses in the oil were greatly reduced by using a larger oil tank; with a tank ten inches in diameter the stresses were only 20 to 30 per cent. of those developed in a tank 8 inches in diameter. After a number of severe short-circuits it was found that only 5 per cent. of the oil had been thrown out by the expansion of the gases and the internal pressures never went above 120 pounds per square inch. The author stated that the devices added to the switches to obtain these unusually favorable results can be added to any ordinary oil circuit-breaker without any radical changes.

Following the two papers just mentioned, Dr. Charles P. Steinmetz presented a very interesting paper on the development of the modern central station, in which he outlined the evolution of the present huge aggregations of machinery and distribution systems from the old Edison direct-current three-wire station of twenty years ago. After following the development up to the present form of alternating-current station delivering high-tension three-phase currents to substations which convert it into either alternating current or direct current of lower voltage, according to the local requirements, Doctor Steinmetz pointed out in detail the necessity and advantage of using reactances between the sections of the station busbars as well as in the generator leads and in the feeders, the object being not only to limit the current which would flow in the event of short-circuit but to enable stations widely separated to be operated in parallel without difficulty.

The three papers were discussed together. John W. Lieb, of the New York Edison Company, said that his company had found large differences in the internal reactances of turbo-generators—differences of as much as two to one—which led him to suggest that the inherent reactance of the modern turbo-generator could be considerably increased and the amount of external reactance required for the purposes described in the papers thereby greatly reduced.

M. H. Collbohm considered the use of reactances for reducing short-circuit current to be a makeshift; he disapproved of impairing the regulation of a synchronous generator for that purpose and thought that the use of the induction generator would be much better. A station equipped with such generators and containing synchronous motors running idle to supply the exciting current he thought would be entirely feasible. Stations thus equipped would operate more smoothly in parallel and a water-power station of this type could be readily operated in parallel with a steam station probably without the use of hydraulic governors, and thereby utilize the full energy of the stream under all conditions.

D. B. Rushmore said that if the internal reactance of a generator were increased it would greatly increase the difficulty of making repairs, but he did not explain why or how. What is needed, he said, is a reactance that will increase with large current increase, so that under normal conditions the reactance would not greatly impair voltage regulation but under short-circuit conditions its counter e.m.f. would increase and keep down the abnormal flow of current.

C. W. Stone expressed the opinion that a generator built to have twice the internal reactance of the present designs would not have as great a factor of safety. Moreover, its reactance would not serve to limit the effect upon the system of a short-circuit within its own armature windings.

TABLE 1. COST OF CONSTRUCTION

Power Stations:		
Building, stacks, coal- and ash-handling machinery	$354,000	
Equipment	640,900	
Total		$994,900
Transmission line		241,500
Substations:		
Buildings	72,000	
Equipment	419,560	
Total		491,560
Third rail		557,636
Overhead trolley		80,500
Track bonding		102,659
Cars		1,135,900
Car-repair and inspection sheds		46,674
Right-of-way, additional		592,100
Reconstructing tracks		763,800
Constructing new tracks		2,071,000
Terminal facilities and changes at stations		252,400
Signals and interlocking plants		561,900
Changing telegraph and adding telephone facilities		105,100
Fencing right-of-way, cattle guards, etc		88,400
Miscellaneous items		44,200
Total		$8,130,229

UNIT COST OF ELECTRIFICATION

Power station, cost per kilowatt	$110 00
Transmission line, cost per mile	3,485.00
Substations, building and equipment cost per kilowatt	28.90
Third rail, cost per mile	4,235.00
Overhead trolley, cost per mile	4,120.00
Track bonding, cost per mile	684.50
Cars, including electrical equipment each	12,214.00

Cost of Electric Railway Operation

B. F. Wood presented a paper relating to the electrical operation of the West Jersey & Seashore Railroad (a double-track line from Camden, N. J., to Atlantic City), which was remarkable and highly commendable for the completeness and frankness of information presented. The power station, located at Westville, N. J., is equipped with four Curtis turbo-generators of 2000 kilowatts each, generating three-phase alternating currents at 6600 volts, which are stepped up to 33,000 volts by air-blast transformers in the station. The alternating current is stepped down and converted to direct current of 675 volts in eight substations provided with the usual equipment of transformers and rotary converters. The length of the main line of road is 64.6 miles and there is a branch line of 10 miles from a point about half way on the main line. The third-rail method of communication between the car motors and the line is used. The cost of changing the line from a steam line, about half of which was single track, to the present electrical lines, is given in Table 1.

Table 2 shows the cost of operating the power station in complete detail for the year 1910, and Tables 3 and 4 show the cost, by months, of maintaining the transmission system and the substations.

TABLE 3. COST OF MAINTENANCE OF TRANSMISSION SYSTEMS FOR THE YEAR 1910

Month	High Tension		Overhead Trolley		Third Rail		Running Track Bonding	
	Total	Per Mile	Total	Per Mile	Total	Per Mile	Total	Per Mile
January	$142.96	$2.04	$690.84	$35.32	$492.96	$2.74	$26.67	$1.51
February	409.74	5.85	266.38	13.62	580.80	4.41	562.82	3.75
March	198.62	2.84	381.28	19.49	495.55	3.76	39.26	0.26
April	403.44	5.76	446.57	46.71	745.16	5.26	30.24	0.20
May	256.14	3.66	291.51	30.49	1,126.40	7.95	190.05	1.27
June	123.21	1.76	864.62	90.44	957.42	6.75	312.08	2.08
July	167.90	2.40	393.62	41.17	818.29	5.77	494.79	3.30
August	357.20	5.10	317.49	33.21	1,631.72	11.51	32.99	0.22
September	508.51	7.26	389.73	40.77	838.87	5.92	202.05	1.35
October	604.93	8.64	245.75	25.70	647.27	4.57	98.66	0.66
November	171.58	2.45	363.35	38.01	11,062.98	7.50	189.83	1.26
December	100.34	1.43	244.02	25.52	1,466.71	10.35	125.03	0.83
Year	$3,444.57	$4.10	$1,895.16	$36.70	$10,861.13	$6.46	$2,445.72	$1.36

TABLE 4. COST OF OPERATION AND MAINTENANCE OF SUBSTATIONS FOR THE YEAR 1910

Month	Total for Eight Substations				
	Operation	Maintenance	Total	Cost per Kilowatt-Hour	Substation Output Kilowatt-Hour, 675 Volts Direct-Current
January	$1,573.82	$373.10	$1,946.92	$0.001136	1,655,800
February	1,601.78	147.39	1,749.17	0.001157	1,460,200
March	1,618.16	174.27	1,792.43	0.001035	1,678,100
April	1 728.98	275.64	2,004.62	0.001251	1,554,900
May	1,760.46	370.91	2,131.37	0.001267	1,635,900
June	1 794.44	432.55	2,226.99	0.001310	1,655,600
July	2,006.97	317.62	2,324.59	0.001047	2,175,700
August	1,751.03	194.13	1 945.16	0.000811	2,349,000
September	1,776.14	903.45	2,679.59	0.001285	2,035,200
October	1,744.23	145.99	1,890.22	0.001069	1,712,100
November	1,750.62	142.23	1,892 85	0 000986	1,860,100
December	1,745 68	130.02	1,875 70	0 000829	2,199,400
Year	$20,852.31	$3,607.30	$24,459.61	$0 001082	21,972,300

TABLE 5. GENERAL POWER DATA

Month	1909				1910			
	Alternating Current Kw.-hr. Power Station Output	Cost in Mills per Kw.-hr. Output	Lb. of Coal Kw.-hr. Output	Efficiency Power Station Bus to Substation Bus	Alternating Current Kw.-hr. Power Station Output	Cost in Mills per Kw.-hr. Output	Lb. of Coal Kw.-hr. Output	Efficiency Power Station Bus to Substation Bus
January	1,959,700	5 67	3 23	76.1	2,131,000	5.15	3.31	81 8
February	1,756 500	5.71	3 25	76.1	1,865,300	5 73	3.46	82 4
March	1,903 600	6 04	3 33	76 1	2,168,600	5 42	3.27	81 3
April	1,869.300	5.90	3.27	75.0	2,031,400	5 62	3 22	80.1
May	1,788,800	5.65	3.26	75.5	2,115,900	5 25	3.27	79 5
June	1,749,200	5.77	3.22	77.7	2,167,500	5 68	3.14	80.3
July	2,426,000	5.21	3.25	78.0	2,784,300	5.88	3.16	82.5
August	2,324,400	5.27	3.34	81.5	3,088,300	5 11	3.06	80 7
September	2,056.100	5.28	3.34	80.3	2,590,400	5.17	3.31	82.9
October	1,836,600	5.40	3.27	80.1	2,229,000	5.48	3.17	80.8
November	1,869 500	5.49	3.41	80 7	2,381,500	5.19	3.29	81.9
December	2,154,800	5.42	3.41	81.0	2,759.300	5 31	2.39	83.4
Average for year	1,962,600	5 55	3 30	78.4	2,359,400	5 42	3 25	81.6

Table 5 gives a summary of the cost of converting energy, the specific fuel consumption and the efficiency of electrical transmission for the years 1909 and 1910.

The author presented a great deal of other data on operating costs relating to the purely railroad side of the problem, which does not come within the province of POWER.

ELECTRIC-MOTOR CONTROL

In a paper entitled "Automatic Motor Control," Arthur C. Eastwood inflicted upon a body of men assembled for the increase and promulgation of electrical knowledge a commonplace description of a motor controller which his company recently put on the market and which had been sufficiently described in the columns of the technical press months ago. The device is merely an ingenious variant of the well known multiple-solenoid-switch type of motor starter, and is of neither sufficient importance as an item in the progress of electrical engineering nor of sufficient novelty in principle or application to justify its having been given a place on the program.

G. R. Radley and L. L. Tatum read a paper on "Limitations of Rheostatic Control" in which they presented a lot of thoroughly well known and universally recognized facts concerning the minimum practical number of contact points on motor starters and regulators, the results of distributing the starting resistance in different ways between the several sections, the starting characteristics of motors with different kinds of load, the properties of various commercial resistance materials and the temperature considerations in designing a rheostat. The platitudinous nature of the paper is well illustrated by the following extracts: "Coarse steps tend to cheapen the rheostat," "Where the load of a motor at any speed is approximately constant, resistance control is practically, though not always, economical." "The limit of coarseness of stepping is the increase in voltage the motor will stand without objectionable surge of current." "The limiting features in the resistance material appear in getting the current into the resistor and getting the heat out of it." "How to get the heat out of the resistor is determined by a study of the laws of the flow of heat." "The limitations of contacts or switching parts are carrying capacity and commutating capacity" [ability to close and open the circuit]. "Laminated copper leaf brushes giving a well distributed pressure over the contact area are commercially best for large currents."

T. E. Barnum presented a paper on the "Control of High-speed Electric Elevators" which almost comes within the criticisms of both the Eastwood and the Tatum papers. Mr. Barnum described commercial apparatus which is already thoroughly well known to every engineer in the country who has the slightest professional interest in elevator work and presented a few expressions of opinion as to the comparative merits and appropriate fields of the worm-gear and the traction types. His paper was relieved of entire barrenness, however, by the inclusion of some interesting curves showing the performance during acceleration and retardation of different elevator equipments and with different types of control and some general figures as to power consumption. He emphasized the fact that comparison on the basis of power consumption is usually unsatisfactory, citing the following figures: A gearless traction elevator running empty and stopping at every floor in both directions took 6.4 kilowatt-hours per car-mile; the same elevator with maximum load and again stopping at all floors required only 10.4 kilowatt-hours per car-mile. Carrying two-thirds of its maximum load and stopping at all floors it took 8.8 kilowatt-hours and with the same load, stopping only at the top and bottom of the well, it took only 2.4 kilowatt-hours per car-mile.

OVERHEAD WIRES

A valuable paper on the sag of overhead wires was presented by W. L. R. Robertson, in which very comprehensive formulas and charts were offered for the solution of sag and span problems for all usual conditions. A kindred paper was presented by Prof. Harold Pender and H. F. Thompson, but this one was even more comprehensive, including a consideration of both the mechanical and electrical features of transmission-line construction and maintenance. The mathematical and graphical character of both papers makes it impracticable to abstract them or even to present a rough synopsis of their tenor.

Voltage Troubles in Small Alternators

BY H. K. SPRAGUE

In the operation of small alternating-current generators, poor voltage conditions sometimes cause a good deal of annoyance to the attendant in charge of the equipment because it frequently happens that electrical machinery of limited capacity is placed in charge of men whose training and experience have been almost entirely along the lines of steam-boiler and small-engine operation. The causes of poor voltage are in the main so readily determined that everyone should know what they are. Low voltage may be due to the speed of the generator or that of the exciter being below the normal; to the reversal of one or more field-magnet coils; to incorrect switchboard instruments; to the current in a compensating field winding being opposed to that flowing in the main field-magnet coils; to incorrect setting of the rectifier brushes or of the exciter brushes, or to leaving too much rheostat resistance in the alternator field circuit. If the exciter series field winding is reversed or short-circuited, or if a part of the exciter shunt field winding is reversed, low voltage will result at the generator terminals because of insufficient excitation.

It always pays to remember that the voltage delivered at the terminals of any generator, either direct current or alternating, depends primarily upon three factors: the speed of the revolving part, the number of armature conductors within the influence of the field and the strength of the field. All three of these factors are present in both the alternator and its exciter. They are not complex in themselves and their effects therefore may be quickly determined and easily controlled.

Increase of Electrical Power in South Africa

Consul Edwin N. Gunsaulus, of Johannesburg, Transvaal, reports some interesting facts relative to the progress of electricity on the Witwatersrand, as shown in the annual report of the government mining engineer. There was a large increase in the use of electrically driven machinery in connection with the mines, the horsepower of motors having risen during the year ended June 30, 1910, from 76,299 to 108,354. Owing to the fact that the electrification of the power supply of a majority of the mines is now rapidly going ahead, this total will be largely increased during the present year. This scheme contemplates not only the employment of motor-driven turbo-compressors for supplying compressed air, but motors will also be used for winding and pumping and in a majority of cases for the mill drive. The induction motor has been chosen by many of the mines for winding purposes, this being generally the case when it was necessary to convert an existing steam hoist, but it is understood the Ward Leonard system has been adopted in most instances where a completely new winding plant was required.

The rated capacity of the stations now in process of construction by the Victoria Falls Power Company and the Rand Mines Power Supply Company, Limited, is: Brakpan, 12,000 kilowatts; Simmer Pan, 18,000 kilowatts; Driehoek, 3000; Rosherville, 50,000 kilowatts; Vereeniging, 40,000 kilowatts. The first three are practically completed, and the Rosherville station is under construction. In addition to the supply available from the above mentioned companies, several groups of mines have their own electric-power stations either in process of construction or enlargement.

Readers with Something to Say

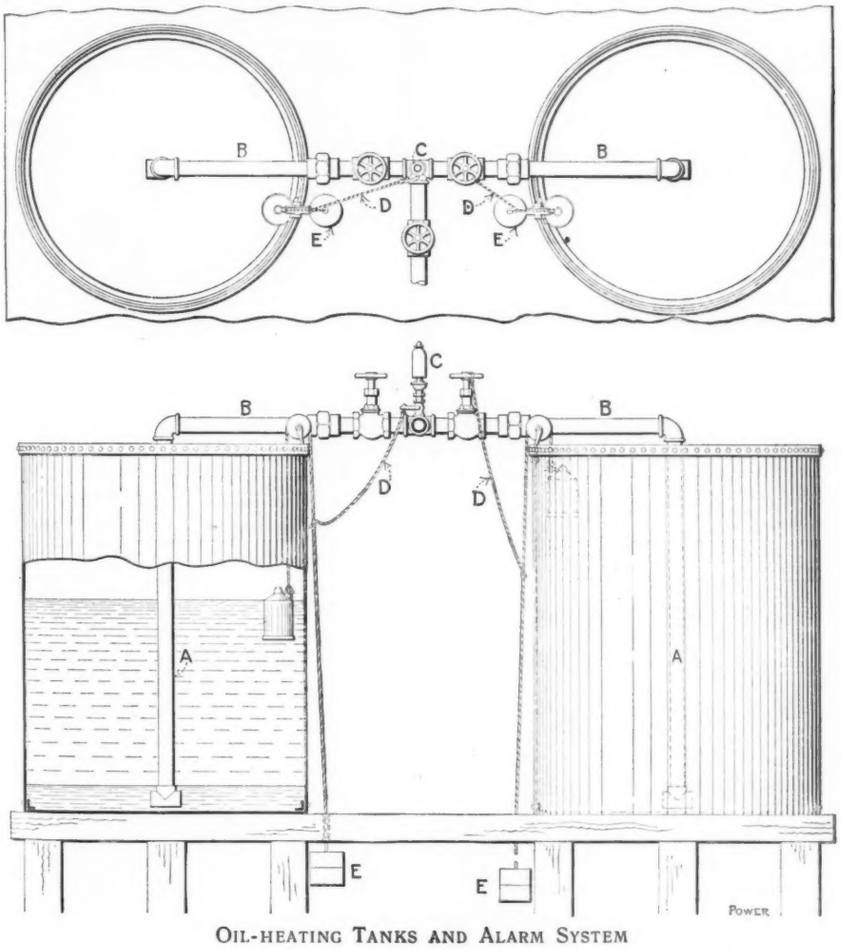
Practical information from the man on the job. A letter good enough to print here will be paid for. Ideas, not mere words wanted

Fuel Oil Heating and Alarm System

I have noticed very little data published relative to oil-burning plants in general and do not understand why. I suppose that if someone would start a discussion, the oil-burning engineer would have something to say.

As engineers find it necessary to use live steam to heat the fuel oil, the following may be of interest to them:

At the plant where I am employed two oil tanks are arranged as shown in the accompanying illustration, each of 100 barrels capacity, set on a platform about 7 feet above the ground level. By having two tanks it is possible to heat and burn the oil in one while drawing it from the other. The live-steam connections are arranged as shown. The pipes *A A* should be placed in the center of the tank, each having a tee on the lower end which should rest on the bottom of the tank. There should always be enough water in the tank to cover the tee openings, as the live steam being discharged directly into the oil will cut it and some of the moisture will remain suspended. I once found it necessary to boil a 250-barrel tank of oil for 48 hours after it had been cut by steam in this manner.



OIL-HEATING TANKS AND ALARM SYSTEM

The whistle alarm is quite necessary in the plant mentioned, as it is the firemen's duty to fill these tanks, and it seemed that they were always busy at something else when the tank got full. The whistle can be heard in the most remote parts of the plant. It is installed and operated as follows:

B is the steam line used to heat the oil. The whistle *C* is placed in the 1-inch tee drilled and tapped for it. *D* is the cord to which is attached a jug, tightly corked, which acts as a float. The cord runs over a small pulley at the top of the tank and down the side through a hole in the platform. The weight *E* is attached to the end of the cord and is heavy enough to work the whistle-valve lever when the oil reaches a predetermined hight.

When the whistle starts sounding, the tone is low at first, increasing in volume as the valve continues to open, and blows until the hook connecting the cord to the valve lever is removed. It is necessary to go to the top of the tanks to stop the flow of oil, but this is no inconvenience.

When filling the other tank the whistle lever is turned half way around and is operated in the same manner as with the other tank.

B. S. HARTLEY.

Tipton, Cal.

Handling the Draft

Most firemen hold the idea that the longer the damper remains closed the more coal they are saving. This is wrong, because it is necessary to burn coal rapidly to get the best results. This cannot be done with the damper closed and it is no more reasonable to close the damper too early than it is to close the exhaust valve of an engine too early.

A pound of coal will give up between 12,000 and 14,000 B.t.u. while proper combustion is taking place, whether it be one minute or one hour. I would not close a damper earlier than 10 pounds above the working pressure and would cut down the boiler capacity so that bright fires would be required to handle the load. It may take a little of the engineer's time to teach the fireman to handle the fires so as to maintain a steady steam pressure, but it can be done with a little perseverance, and then it will be unnecessary to use the surplus radiating surface of an extra boiler.

Too much attention cannot be given to the boiler settings. Walls with an air space are meeting with little approval nowadays. Instead of leaving an air space I have packed asbestos on each side of the boiler extending from the front to the rear and as low as the

grates. This space was about 4 inches wide, with several bricks put in as stretchers to stay the wall. As a consequence, the radiation of heat from the furnace has been greatly reduced.

W. D. DUMAR.

Attleboro, Mass.

Sectional Damper Regulator

Some time ago, while acting as master mechanic of a New England textile mill, I was considerably annoyed by the frequent binding of a 10-foot damper that controlled the furnace draft from the stack end of the economizer flue. No sooner was one cause effaced than another would arise. The damper really needed renewing as it showed considerable wear, the effect of 15 years' exposure to the gases, but because its replacement would necessitate the removal of a part of the side wall and cause sundry delays I had postponed the disagreeable task from week to week.

Finally, I evolved the plan of erecting a new damper in three sections, each measuring 3 feet 6 inches by 6 feet in dimensions. These sections could be readily passed singly into the flue through the end doors and pulled along under the economizer tubes to places where they were assembled.

Fig. 1 illustrates the damper as erected and the method of its control. The full lines show the closed position and the dotted lines represent its open position, also that of the operating levers. A young engineer to whom the operation of the power plant was entrusted was very enthusiastic about the change made and one day he exhibited sketches of an arrangement, showing how the damper regulator could be made to control each individual section independent of the other. His idea was to close one section when the steam pressure was within 7 pounds of maximum, a second when within 5 pounds of maximum, and the third section to shut when the steam pressure was within 3 pounds of the blowing-off pressure. He was positive that such an arrangement would result in the saving of considerable fuel and from the ardent manner in which he delivered his arguments I became so convinced that good results would be obtained by their incorporation that I at once prepared to adopt his ideas. The controlling valves, hydraulic chambers, etc., were all made in our small machine shop, and in their construction and assembling I was careful to follow the young engineer's details.

I had no doubt that the result would prove a decided benefit as an object lesson if in no other way. One of the arguments for the scheme was that as the rather heavy draft would be somewhat reduced at the working pressure the firemen would be compelled to fire lighter and more often. My mental comment was that the engineer would be the one to compel them to do this, for I foresaw that he was about to enter on a course of instructions to the firemen that would compel his damper scheme to show a material saving of fuel. I was right for the logbook figures showed a substantial saving of 6 per cent.

Later, however, after the firemen had become proficient, I opened fire on the scheme, contending that the saving in fuel was really due to the changed method of firing and that with a strong draft, a higher furnace temperature would be obtained. One day I cut out one boiler, disconnected the damper mechanism and restored the damper to its former condition. The result was an object lesson to my assistant.

I believe his scheme possesses many points of interest to engineers and may aid some to better the control of the air supply to heating coils, drying rooms, or anything else other than the control of furnace draft. For this reason a short description of the apparatus may be of interest. Referring to Fig. 2, *A A A* indicate the three hydraulic chambers, one to manipulate each of the damper sections. *B B B* are the three controlling valves which admit water to the chambers and control the discharge of the waste water. The device operates as follows: When a predetermined steam pressure is reached the weight *D*, lever *G*, and the valve stem of *B* are raised slightly, the amount depending on the leeway allowed between the lever and the toe of the screw *H*. When the steam pressure is sufficient to overcome the gravity of the additional weight *K*, the lever *G* again rises until it comes in contact with screw *L*, lifting the valve stem of the second valve.

Fig. 3 illustrates one of the controlling valves in detail and shows how each section of the damper can be operated independently of the other.

CADWALADER HUGHES.

Saxonville, Mass.

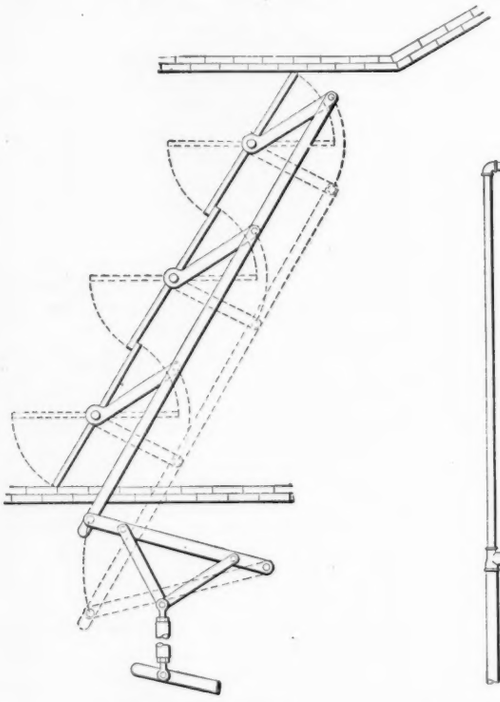


FIG. 1. DAMPER

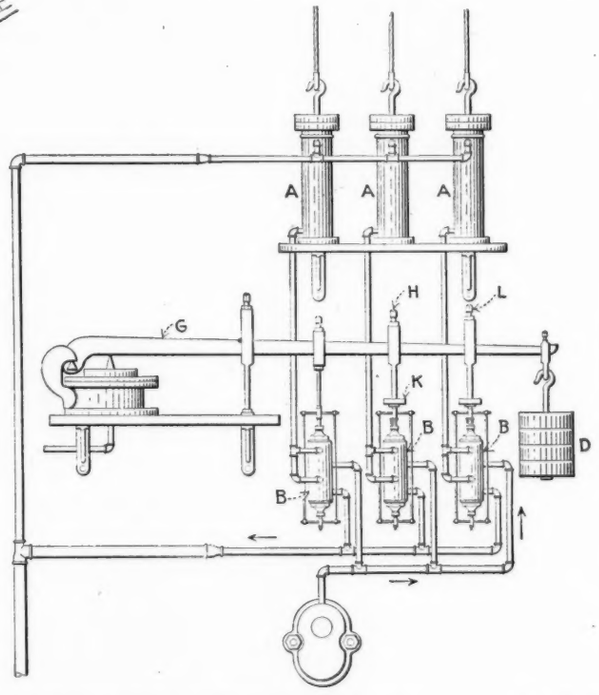


FIG. 2. ARRANGEMENT OF HYDRAULIC CYLINDER

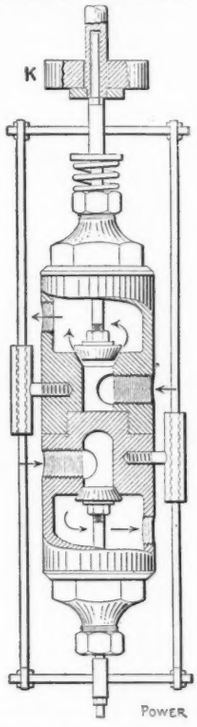


FIG. 3. CONTROLLING VALVE

Recording Instruments for Small Plants

In these times of competition between the isolated plant and the central station, the neglect of accounting methods in the former is regrettable. The majority of small manufacturing concerns employ all sorts of red-tape formalities to reduce the waste of material, but in the power plant practically nothing is known about the power obtained from the coal consumed.

All necessary apparatus can be purchased for a few hundred dollars, and practically entail no extra work on the part of the employees. In about 90 per cent. of the small plants such instruments would pay for themselves in a very short time.

The instruments required are usually an automatic water weigher or a reliable meter, a recording-pressure gage and a recording feed-water thermometer. Some method of weighing coal is, of course, desirable, but in the small plant, where coal is delivered about as used, this can be approximated very closely when the time of the run is for two or three weeks.

In many steam plants the engineer takes electrical readings every 15 minutes. In the average plant this alone is not worth the trouble, as steam is generally used for industrial purposes and is very apt to vary, but the electric load on the switchboard will average up evenly.

A water weigher should be read once each day and this reading, with the charts from the recording instruments, should be delivered to the man in charge of the plant. These records, taken for a month, and that of the total coal consumption, afford a practical power-plant test. The addition of wattmeter readings also points out how much of the load is for power and how much is for other purposes.

Coal showing good economy in one furnace may not give satisfactory results in another, and it is evident that a saving in fuel can be made in any furnace if the right kind of fuel is burned. With proper recording instruments the engineer may experiment with the different grades of coal until he has determined which is the most efficient for his plant.

To know the chemical and heat values of coal is important in checking up the value of the coal as it is delivered to see if it is up to the contract specifications.

Experts do not agree on the best method of firing as so much depends on the furnace. The instruments will also enable one to determine which particular method of firing is best for any type of furnace.

Steam is frequently lost because of leaky return pipes from the heating system. This is liable to happen when the returns are not readily accessible for inspection. The temperature of the feed water will indicate the amount of steam being returned to the heater.

Where the coal can be weighed as used it is a close check on the fireman, and the difference in coal fired per pound of water evaporated by the men will be surprising. This will also start a rivalry between firemen which will have a beneficial effect on the coal pile.

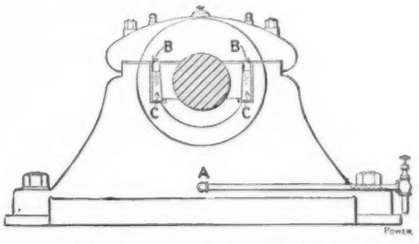
The central station offers to furnish current at a certain price. With proper instruments in a plant the buying of power is not guesswork. Power can be purchased for a guaranteed price, and if the isolated plant is not producing power at as low a cost a reliable test should be made to determine what percentage of the total cost of power should be credited to the switchboard and what percentage for industrial purposes. The latter must be furnished even if current is bought and must be taken into consideration before condemning the isolated plant.

JOHN BAILEY.

Milwaukee, Wis.

Main Bearing Experiences

Some time ago, while in charge of an 18x36-inch Corliss engine, I was greatly bothered by the tendency the main bearing had toward heating. I experienced but little relief after thoroughly cleaning what I could of it, and cooling dopes proved their uselessness. I was



AIR PIPE TO MAIN BEARING

soon compelled to discard the oil cups and to flood the journal with a stream of oil flowing directly from the gravity feed pipe. I had no time to jack up the shaft and rebabbitt the journal, as it was imperative that the engine be kept in service seven days a week.

Some relief was had by running a pipe line from an air receiver to a hole drilled in the side of the pillow-block, as at *A* in the accompanying illustration. The air escaped from every opening around the shaft.

About this time there appeared in POWER discussions concerning the best method of cutting oil grooves in large journals. Some favored smooth bearings with no channels whatever, and others related how they got relief by cutting the oil grooves in the shaft instead of in the babbitt. In this vexing dilemma I was willing to try anything which gave promise of relief, so I cut grooves in the shaft, with the result that my troubles completely disappeared. Let not the advocates of this method rejoice unduly at my success, however, for as I was cutting the channels the chisel encountered a substance difficult to chip, a piece of cast steel imbedded in the softer material of the shaft. Its position corresponded with a shallow groove worn in the babbitt of the quarter boxes; and I believe it was the removal of this sharp alien matter that cured my trouble, and not the cutting of oil channels.

I was once called into a neighboring plant to see if I could ascertain what caused a large, main driving belt to run considerably to one side of the flywheel. The trouble was remedied by leveling the engine shaft, which was easily accomplished, as the main inboard bearing was equipped with a bottom wedge placed there for that purpose. But why the engineer could not attend to this puzzled me until he explained that he not only took up on the side liners of the main journal, but also took up on the bottom wedge. He believed that the sole box wore as much as the side boxes and that they should, therefore, be taken up the same amount. This would be all right, provided he frequently centered the piston and paralleled its rod with the guides; but evidently he overlooked the fact that there were no ready means of adjusting the sole box of the outboard bearing.

Most all main pillow-blocks are constructed somewhat on the same principle; yet, once in a while, a designer will introduce some novel feature which surprises the engineer. I once ran a high-speed Corliss engine, with the side outline of the main bearing looking like the illustration shown. The oblong pieces of boards *B B* are about ⅞ inch thick, which form a buffer for the wedges *C C*. Why wood is used here, was never explained to me; and I conjecture that its purpose was to deaden pounds, which might arise at this point.

On one occasion I was sincerely thankful that it was wood, and not metal; for, one day, one backed out of its place, an inch or so, and an upper corner caught in a rib of the exhaust eccentric. Immediately there was trouble, which made its presence known by the shot-like popping of the cylinder-relief valves. When the engine was stopped it was discovered that the sudden impact between the metal and the wood had caused the eccentric to slip; and as a result, compression in the engine cylinder became abnormal. I believe that if the liner had been made of anything less easy to splinter than wood, we would have suffered at least a broken eccentric.

WILLIAM POWELL.

Ashland, Mass.

Questions Before the House

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues

Writing for the Technical Paper

I have noticed several contributions in the technical journals on the subject of writing for the technical paper, and I will try to say a few words that may help those who are backward in giving others the benefit of their experiences, as well as to those who might profit by them. No one man's experience can be as broad as are those of a great number of men. Our most valuable knowledge comes from reading the experiences of others.

There were at one time many, and there are yet a few, engineers who are so selfish as to keep to themselves everything they know, or think they know. The engineers who give others the benefit of their experiences receive in return the experiences of others, and their knowledge grows accordingly. The noncommittal engineer never gets very far.

Often we think we have the right idea, or the right solution of a problem, and we send it to our paper. The first thing we know some fellow gets after us and shows us that we are wrong. We are therefore possessed of additional knowledge which has cost us practically nothing. It is no disgrace to be mistaken; we are not the only one who have made mistakes.

When we are convicted of error in this manner the effect is wholesome; I know because I have been the criticized as well as the critic, and I am proud to say that I have taken my medicine with good grace. Our best friend is the man who tells us in a nice way where we are in error, and our next best friend is the fellow who tells us anyway, even if he may not be as considerate as we feel he ought to be. We dislike to be convicted of error, but this dislike operates to our great advantage; having once been convicted, we will think pretty hard before committing ourselves a second time, and the habit of thinking is certainly a good one to acquire.

On the other hand, we may find some brother engineer seeking just the information we have obtained through our experience. Here is an opportunity to help others and help ourselves at the same time. I say this because, in a broad sense, anything which elevates the individual engineer contributes just so much to the elevation of engineers as a class, and therefore it is our duty to do all we can to elevate the standing of the engineer, individually and collectively.

Writing is simply a matter of effort. If a man can talk with his brother engineers, as nearly any engineer can, there is no reason why he cannot write as well as he talks. If he did not try, he would not be able to talk. Many engineers who think nothing of writing to another engineer and telling him of some experience, and thoroughly describing everything connected with it, would not think of writing of this same experience for his technical paper. Perhaps if they realized the possible value of some of their experiences to other engineers they would have less hesitancy in going into print.

WILLIAM WESTERFIELD.

Lincoln, Neb.

The Need of an Institute of Operating Engineers

The poor working conditions of operating engineers, the slight favor in which they are held by many employers as compared to the employer's respect for a consulting engineer, and the very poor wages generally paid are frequently set forth in POWER.

We need organization, but there are inherent conditions which, because of scattered and isolated places of employment and lack of suitable public-safety laws, limit the scope and freedom of action of an engineers' organization. Most operating engineers' organizations have the fraternal and beneficial elements, but the benefit of their educational advantages to the individual engineer depends directly on his own ability to understand and his ambition, and as there are no grades of membership, he is not rated according to his ability, or elevated in proportion to his experience, knowledge, ambition, etc. Modern industrial conditions make it necessary tc begin a movement of genuine self-help and uplift for the engineer as an individual.

Many years ago the engineer simply started and stopped the engine and made steam; he could qualify in a day. With improvements, larger units, and increased pressures and power the engineer served as a handy man or a mechanic; he made the adjustments and repairs, but lacked the technical knowledge.

The demand today for skilled, practical and technical men is not fairly compensating the engineer for his ability to operate the close-design, high-efficiency plant. An engineer cannot, on account of his isolation, be coöperative and companionable.

The lax laws in many cities and towns and the employer's ignorance of efficiency, economy and possible improvements in operating a plant are also formidable reasons for these conditions. The eight-dollar man is often as acceptable to the employer as is the twenty-dollar man, though the former's carelessness or ignorance may cost from two to ten times the salary of a skilled engineer.

While there are engineers who receive from $20 to $40 a week, many only receive $9 to $15 for seven 12-hour shifts, including the holidays. In some instances they are compelled to do the wiring, firing, belt repairing, piping, take care of radiators and machinery, and assist in the shipping room.

If the owners and the public coöperated they would realize that efficiency and safety are not to be had after this fashion; that our laws would be better, and an employer would be suspicious of the man who would work for low wages.

I concur with G. G. Hall in the March 28 issue of POWER when he says that he sees no reason why a chief engineer should not be able to install a plant if necessary; that engineers should break away from plant routine occasionally and view the plant from an outsider's standpoint. When his employer knows, say, by a certificate, that the engineer is fully qualified, improvements will likely be made. Through the coöperative and educational features in the plans of the Institute of Operating Engineers the employer would know his engineer's abilities.

The operating engineers should be able to convince his employer that heat principles and mechanical and theoretical operating conditions are best understood by the engineer and that they should be intrusted to a well paid, good-grade engineer.

I agree with H. H. Burley, in the April 18 issue, that the solution of these problems does not rest so much upon an organization resolved to stick together as it does upon one with a view to raising the individual standard along educational lines; that the time is ripe for all to come under one name and one purpose and to get busy.

An engineer cannot demand higher wages until he can convince his employer of the danger and the lack of efficiency in the employment of low-grade men. Coöperation is necessary.

There are some who are afraid of encouraging the colleges and schools because of what might be called machine-made engineers. Nothing is farther from the truth. A school does not claim to make a student an engineer, but only a better engineer than one without its assistance.

The plans of the Institute of Operating Engineers, by apprenticeship, lectures, libraries, etc., aim to help us to be better qualified for our work, and to give the employer a better idea of what our services are worth.

Ultimately, a qualified member will be able to properly install and operate in an economical and businesslike manner any modern plant.

It is obvious that in a few years' time an engineer who cannot get the very best results will not have charge of a plant of any importance.

We owe much to our technical magazines for their advice, their uplifting editorials and cheerful answers to problems.

The Institute of Operating Engineers will also be of great benefit to the public, and through public safety to better laws.

Remember the positions with salaries instead of the jobs at wages go to the professions, so ours must be elevated to an acknowledged profession.

WILLIAM C. THORNE.

Vineland, N. J.

Central Station versus Isolated Plant

I have been much interested in the "Central Station versus Isolated Plant" discussion.

The plant in which I am an engineer is located in a small country village nearly five miles from a railroad, and all of our coal has to be hauled by teams. The coal (Pennsylvania Morrisdale) costs $5.35 per ton, laid down at the plant. Between the boiler and engine there are 148 feet of straight pipe and 7 ells. The engine is 11x15 inches in size and runs 240 revolutions per minute. The initial steam pressure is only 85 pounds, whereas the gage pressure at the boiler is 110 pounds. About 93 horsepower are developed by the engine. During the day run of 10 hours, somewhat more than two tons of coal is consumed. To this must be added a small amount which is used by the watchman during the night.

In the majority of the articles I have read on this subject, the engineer is more or less to blame for the conditions which cause the general manager to look up central-station prices. Such is not my case. My engine is working as well as an engine of its type can be made to work. I put my indicator on regularly and keep an accurate record of what it is doing. As I do my own firing it goes without saying that the quantity of coal used is as low as possible. I am producing power cheaper, by the general manager's own admission, than my predecessors, but I am compelled to agree with him that central-station power is still cheaper for us under present conditions, which cannot be altered without prohibitive expense. Thus it is up to me to take a "central-station pill," although the manager has made it an easy dose by adding to my file of recommendations.

EMMET BALDWIN.

Sturbridge, Mass.

Corrosion of Steam Boilers

I notice in the June 13 issue an article by Walter C. Edge, on "Corrosion of Steam Boilers." On page 911, Mr. Edge states as follows:

"A solution of caustic soda in water is known as soda lye. For ordinary cases, 40 pounds of soda ash, 60 pounds of sal soda or 35 pounds of caustic soda per 1000 gallons of water will be sufficient to precipitate most of the scale-forming matter. The cost of treatment with soda is very low, only about one grain of soda ash being required for each grain of sulphate."

The writer believes that the above must be a misprint as regards the amount of water to be used, as 40 pounds of soda ash to 1000 gallons of water would make the water impossible to use for boiler purposes.

Our experience in softening water shows that the average hard water throughout the country only requires from one-half to three pounds of soda ash per thousand gallons, and very seldom do we find waters that require much more than this, although we are treating several.

A water containing 21 grains of calcium sulphate might, according to Mr. Edge's figures, require approximately 3 pounds of soda ash per thousand gallons in addition to the lime that we would use in our process.

For a water to need 40 pounds of soda ash it must contain over 200 grains of sulphates, which would certainly be very exceptional.

F. S. DUNHAM.

Chicago, Ill.

Furnace Questions

The questions put by Mr. Dixon in the June 13 issue under the above heading are on points demanding thoughtful attention if high furnace efficiency is to be attained. While many present-day furnace installations are all right, there are many others that are entirely unfit so far as efficient results go, either because of faulty design or wrong operation.

Some automatic stokers have one very weak point in their design—they admit air at the wrong points, at the wrong time and in the wrong quantity. The other day I was watching a stoker of the inclined-front type and I noticed that at intervals it would open up and cold air would rush in through a slot some 2½ inches wide, extending across the furnace for its entire width. Certainly this cannot be the best way in which to feed air to a furnace: a sudden rush of air, going in at intervals.

I have proved to my own satisfaction that much economy can be effected by providing the right amount of grate area required by a given boiler. Some years since we had some large boilers which were working under a light load. The fireman, who was considered to be a good one, carried an open coking fire. I noticed, however, that it was dead in many spots. By removing two sections of grates on each side of the furnace and putting in blank grate bars a reduction of about 15 per cent. in the coal consumption was effected. No other change was made.

I have tried laying a plate across the rear of the grates just in front of the bridgewall but I did not get as good results as when the space at the sides was blanked off. My explanation of this is that the sides of the furnace are the neglected portions of the grates and are often left bare by the fireman. Hence, by closing them off, the inrush of an excess of cold air at those points is eliminated.

Air spaces are provided in boiler settings for the purpose of insulation. As cracks often occur, a large amount of cold air is let into the furnace and the economy is reduced. I have improved boiler settings by filling the air space with a fine sand. The sand retards the inflow of air when cracks develop.

Rear-arch door leaks are wasteful. I have made these doors tighter by using in the jambs asbestos cement mixed with portland cement.

I agree with Mr. Dixon that the man who has the knowledge can do much if he will but get about it.

High economy calls for a plate clean both outside and in, and good combustion makes for a clean plate on the outside.

C. R. MCGAHEY.

Baltimore, Md.

Vibration of Steam Reach Rod

In the reply to A. E. S., in the inquiry department, regarding the cause of the vibration of his steam reach rod, let me suggest that there are several other causes for this trouble, viz.: center line of eccentric not in line with the center of the pin on the rocker arm; bore of eccentric not parallel with the face of the eccentric; bore of eccentric too large for the shaft, allowing the set-screws to put a twist in the eccentric when they are tightened; face of eccentric too wide for eccentric strap, making too close a fit; hole in eccentric strap for the reception of eccentric rod not faced off square. Any of the above mentioned defects will have a tendency to cause excessive vibration. Your answer implies that the valves are too tight and that unless they are well lubricated they will set up vibration at starting-up time. Now this is contrary to my experience, as I have always found that where valves were too tight, even with plenty of lubrication, there was no vibration of the rods, but the dashpots had a tendency to hold up and not close the valves properly.

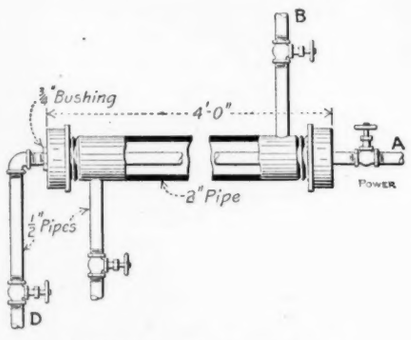
At a large plant in Boston, Mass., I had an eccentric rod break off at the brass-stub end from excessive vibration caused by one of the above mentioned defects. The rod was 1½ inches in diameter. Two other cases happened within my knowledge from the above causes.

J. F. NAGLE.

Troy, N. Y.

How to Condense Steam

In response to Mr. Eldred's request in the June 6 issue, I submit the accompanying sketch, which shows a simple and cheap form of condenser that I have had occasion to use in several plants



CONSTRUCTION OF THE STILL

where the water was unfit to drink. The outside pipe is 2 inches in diameter; the inside one is ½ inch. One of the 2-inch pipe caps should be tapped for a ½-inch pipe and the other one for a ¾-inch connection.

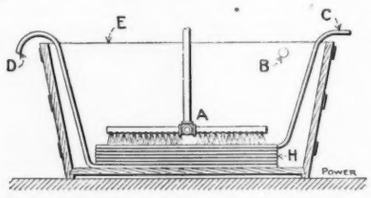
The condenser may be put together as follows: Screw the ½-inch pipe into the cap tapped for ½ inch; then screw the cap onto the end of the 2-inch pipe. Screw the other cap onto the opposite end of the 2-inch pipe, letting the ½-inch pipe extend through the hole tapped for the ¾-inch connection. A ¾x½-inch bushing can then be screwed over the ½-inch pipe and into the 2-inch pipe as shown.

The 2-inch pipe is tapped near each end and on opposite sides for a ½-inch water connection. Cold water is supplied through pipe *B*. Steam is supplied through pipe *A* and is condensed in passing through the ½-inch pipe. Thus, pure water is drawn off at *D*.

J. W. DICKSON.

Memphis, Tenn.

The simple method, used by a large electric-apparatus manufacturer, to distil water for storage-battery work is shown in the accompanying sketch in which *E* is a large tank, open at the top, *H* is a number of lead-pipe coils laid on the bottom of the tank, *C* is connected to a steam supply and *D* runs to the distilled-water tank. An overflow from the tank is provided at *B*, and *A* supplies cold water for condensing the steam which enters at *C*. The overflow *B* runs to the



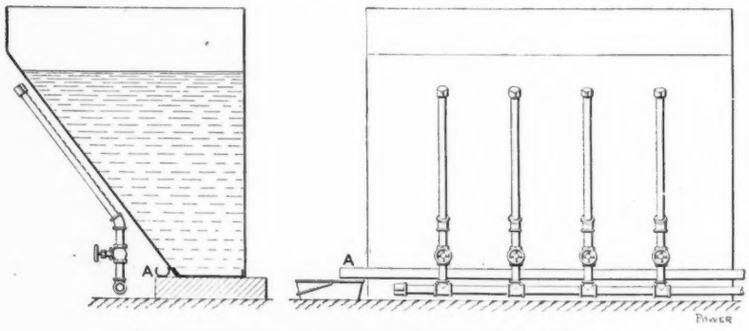
DISTILLING WATER FOR STORAGE BATTERY

boiler hotwell. The arrangement is simple, but does the work.

JAMES E. NOBLE.

Toronto, Can.

In answer to E. G. Eldred in the June 6 number, I would suggest that he drill small holes in a number of steam pipes and allow steam to blow against



STEAM CONDENSED AGAINST SIDE OF COLD TANK

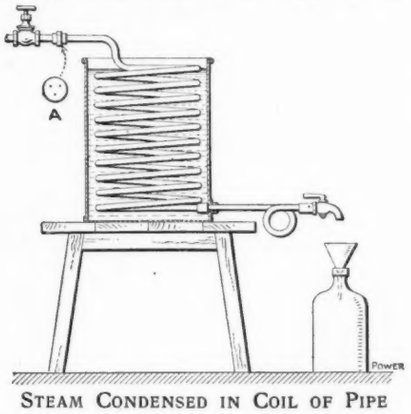
a tank made of sheet iron and filled with cold water. At the bottom have a trough *A* to catch the condensed steam and let it run to a pail. I should build the tank of iron, as zinc or tin might be acted upon by the water. The tank can be made large or small and the number of pipes will depend on the quantity of water desired.

JOHN F. DAVIS.

Northboro, Mass.

To Mr. Eldred I offer the following on condensing steam, which I believe will answer the purpose:

Take a length of ¼-inch pipe and fill it tight with clean sand. Cap up the



STEAM CONDENSED IN COIL OF PIPE

ends, build a good fire and start heating at one end. When hot enough to bend easily, commence to roll it up on a piece of 6-inch pipe, rolling it up as fast as it will heat. Clean the coil of sand and take an old can or make a water-tight box large enough to contain the coil and fit one end of the coil through the side near the bottom of the can. To the end of the pipe connect a ¼-inch pipe loop and onto that place a small spigot to drain off the water into a large bottle or stone jug. On the upper end of the coil connect a ¼-inch union, and file the two faces of the union smooth. Cut a small metal disk *A* that will fit in the union the same as a gasket. Through this disk drill three holes about 1/32 inch in diameter. Put the disk in the union with a thin cut-out gasket on each side of it and connect the pipe with the steam line. Keep the tank filled with as cold water as can be had. The three spray holes in the disk will expand the steam and when it comes in contact with the walls of the coil it will rapidly condense.

L. M. JOHNSON.

Glenfield, Penn.

Management of Men

In the management of men to get the best results the man in charge must have the respect of his men. To get their respect he must treat them as men who are in no way inferior to him except in the matter of work. There are many men who are working in a lower position than they really should be on account of someone higher up who does not appreciate their work and will not give them their just dues. Every chief should watch and study his men and when one shows that he is competent and deserving of advancement, the chief should give him what he deserves, and not show favoritism.

Fair treatment will get better results than unjust treatment. Men dislike a person who is always "cussing" and is "grouchy" with them and they will not do as good work when he is away as they would if he were a man that was respected. Of course, there are some men who will not benefit by good treatment and wtih a man of that kind one has either to get rid of him or make him understand that he will have to do as he is required.

Perhaps nothing will make a man slight his work more when he gets the chance than abusive language. And most men like to have their work praised occasionally.

GEORGE O. GRIFFITH.

Fort Flagler, Wash.

Value of CO_2 Recorder

It was with no little interest that I read Edward A. Uehling's article under the above heading in POWER for June 13, answering my own in the issue of May 9.

I confess, however, to some disappointment in not having received some help to a clearer understanding of the relation of CO_2 records to boiler and furnace efficiency. Mr. Uehling has neither advanced any argument tending to disprove my statements nor furnished experimental data to shed light on the problem. He appears to have read about every second or third line of my article and immediately dashed off a reply; otherwise he could hardly have stated that the writer "presents diagrammatically the results of a number of boiler tests for the purpose of confirming his disbelief in the value of flue-gas analyses in general and automatic CO_2 recorders in particular."

No such "general" disbelief was either expressed or implied, and I would recommend to Mr. Uehling a more careful perusal of the article in question, particularly calling to his attention the statement that CO_2 recorders have a proper place in many boiler rooms which have previously been equipped with other instruments, especially with devices for keeping coal and feed-water records.

My entire argument, perhaps rather feebly advanced, was intended to show that for the average boiler plant without a technical man to interpret results, the CO_2 recorder is a rather questionable investment, to say the least. Also, I hoped to bring forth from someone a clear statement of the value of such a recorder to the everyday coal shoveler.

Mr. Uehling devotes considerable space to the well known and accepted theory of combustion but advances no proof that it is possible to obtain from any furnace a truly representative sample of gas. Therein lies no small part of the difficulty. An automatic CO_2 recorder would indeed be a valuable adjunct to the boiler room if a fair sample could be secured with any degree of certainty. The use of anything for collecting gas samples other than a single, perforated or open-end pipe for everyday use in a boiler flue is beset with many practical difficulties. CO_2 machines, therefore, are frequently installed by the manufacturers by connecting them to a single sampling pipe in the flue. When this is done, what guarantee has the engineer or fireman that a fair sample is secured? It would be easy to make the statement that a sample thus taken is approximately correct, but it would be harder to substantiate the statement. I have personally tried the experiment of connecting Orsats to two different points in the flue within a few inches of each other, drawing simultaneous samples, and have secured widely differing results. If Mr. Uehling had a car of coal to sample for analysis I do not believe he would shovel a pailful of coal from one corner of the car and send it to the laboratory as a fair sample.

Mr. Uehling states that my article is not without value for three reasons, the most prominent being, "because it shows how easy it is to draw false conclusions from insufficient data." I appreciate this statement greatly. It would have served admirably as a text for my first article. It will perhaps be recollected that I there stated that *without* certain other information CO_2 records do not appear to have any great value. Mr. Uehling now comes to my rescue by adding to the two records (coal and water) which I considered requisite, seven other items, "without which," he says, "it is absurd to draw conclusions." In this connection it is a pleasure for me to state that all the data he mentions were secured for each one of the tests, notwithstanding his hasty statement to the contrary. The additional data were not published, the principal reason being that I have not succeeded in establishing any definite relationship between these data and the CO_2 records.

Moreover, the average everyday fireman would not and could not have all this information at hand. If, therefore, as Mr. Uehling states, "it is absurd to draw conclusions" without these data, what does the CO_2 recorder do for the fireman?

It must be borne in mind that in all this argument I am considering the case (which is most frequently met with) of the plant where little or no technical knowledge is available in the boiler room.

The use of a receptacle for collecting continuous samples by water displacement is also attacked by Mr. Uehling. While I am inclined to believe that inaccuracies introduced thereby are slight, still, being short of evidence on this particular point (as Mr. Uehling appears to be in refuting my general argument), I very cheerfully admit that he may be perfectly correct in his contentions.

I might say, however, that I have on several occasions checked a continuous sample taken over a long period of time, against the average results obtained from a large number of individual samples taken through the same sample pipe with very satisfactory results.

Furthermore, several of the largest power producers of this country, though they are still experimenting with recorders, make daily use of this device, and will continue to do so until something more satisfactory appears.

I gladly assent to the statement made by Mr. Uehling that "there are certain fundamental principles and natural laws with which experimental results must harmonize and if they do not so harmonize there is something wrong with the results or the manner in which they were obtained."

Now taking the results of any series of boiler tests in which CO_2 and efficiency results do not seem to agree (and I have yet to see a series in which they do agree), which figures would be most open to question, those on which the efficiency is based (such as coal and water weights, etc.), or the CO_2 figures resulting from the analysis of something from the flue which may or may not be a true sample of the flue gases?

Toward the close of his letter, Mr. Uehling makes the statement, "In all cases high or low CO_2 means high or low efficiency." To this I most willingly subscribe, but it appears to me that it is up to him to offer some evidence that there exist today the facilities for accurately determining the percentage of CO_2 *actually present in the flue gases;* and also to submit results of a series of commercial boiler tests disproving my statement that CO_2 records at the present stage of the game are not trustworthy as measures of boiler efficiency.

I say a series of commercial tests because by a careful system of selection it is naturally easy to prove anything desired.

It is perhaps well to add that the tests reported in my original article constituted two complete series and were, moreover, not conducted for the purpose of proving or disproving the value of gas analysis.

H. S. VASSAR.

Bloomfield, N. J.

Inquiries of General Interest

Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it

Hydraulic Ram

How high will a hydraulic ram raise water? Is it efficient and how should it be set?

F. K. P.

A hydraulic ram will raise water, under favorable conditions, to a hight of 30 times its perpendicular distance below the source of supply, and will discharge water at a hight of 45 feet above itself up to about 500 feet for every foot of effective power head. The efficiency with this lift, however, is so very low as to make its use almost impracticable, but discharging to a hight from 20 to 4 times the head, it has an efficiency ranging from 45 to 70 per cent.

The ram should be set level and so arranged that the overflow may not submerge it, with the supply pipe as straight as possible and of uniform diameter.

Equivalent Evaporation

During a boiler test 14.1 pounds of water were evaporated per pound of combustible from feed water at 266 degrees into steam at 100 pounds pressure. What was the equivalent evaporation from and at 212 degrees?

F. H. P.

If the heat in the water entering the boiler is subtracted from the heat in the steam at boiler pressure and the remainder divided by 970.4, the quotient will be the factor of equivalent evaporation; that is, the number by which the actual evaporation is to be multiplied to reduce it to the equivalent evaporation of feed water at 212 degrees into steam at atmospheric pressure,

$$\frac{1188.8 - 234.7}{970.4} = 0.983$$

is the factor of equivalent evaporation.

$$14.1 \times 0.983 = 13.86$$

is the equivalent evaporation from and at 212 degrees.

Loss of Ammonia

I am confronted with a serious loss in the supply of anhydrous ammonia in a compression system. The leaks are few and unimportant; does ammonia disintegrate? What percentage of the full charge should naturally be lost per annum when the system is in full operation? What is the best method for detecting the presence of ammonia in brine or water? Is there any method whereby calculations can be made as to the amount of anhydrous ammonia required to give a full charge in a compression system?

C. A. O.

With only a few and unimportant leaks in the compression and expansion system, the maximum amount of ammonia charged into the system each year should not exceed from 10 to 25 per cent. of the full charge. The amount lost, of course, depends on the care the plant receives and the quality of pipe work and fittings used in its construction. The greatest loss of ammonia in the compression system generally occurs from the ammonia-compressor piston-rod stuffing box. The loss at this point can be kept at a minimum by maintaining the rod at a uniform temperature; this is arrived at by careful manipulation of the expansion valves.

A great deal of trouble has been experienced of late years, especially in large plants, with the loss of ammonia and in most cases it has been found that the ammonia lost lies dormant in the cooling coils of the system, the liquid having been made practically inactive by mixing with water and by oil entering the system. This difficulty has been overcome in most cases by the use of an efficient ammonia purifier, which must be so installed that the accumulation of liquid in the lowest point of the cooling system can be drained into it.

The presence of ammonia in water and brine can best be detected by using the Nessler reagent. The exact amount of ammonia absorbed by the water or brine can only be determined by chemical analysis, but approximate calculations can be made when using the Nessler reagent, judging from the color of the resulting chemical reaction.

The amount of a complete charge of ammonia for the compression system can be calculated approximately as follows: Figure 0.18 pound of ammonia per foot of 2-inch cooling coils, 0.15 pound per foot of 1¼-inch coils and 0.1 pound per foot of 1-inch coils. About 36 pounds per ton of ice-making capacity is a common figure. In addition to this 250 pounds of ammonia must be allowed for a 25-ton refrigerating machine, 350 pounds for a 50-ton, 500 pounds for a 100-ton, 650 pounds for a 200-ton, and 800 pounds for a 300-ton.

Unbalanced Pressure

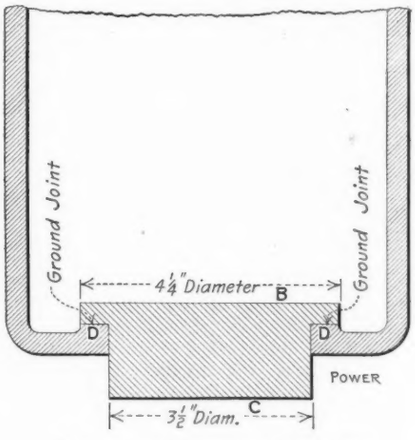
In a vessel with an opening stopped by a plug, as shown in the figure, there is a gage pressure of 125 pounds per square inch. What pressure will be required on the surface *C* to move the plug *B* inward against the pressure in the vessel?

J. S.

Supposing the joints at *D D* to be so tight that there is no pressure between the surfaces, there will be an absolute pressure of

$$125 + 15 = 140 \textit{ pounds}$$

per square inch holding the plug down. The area of a 4¼-inch circle is 14.186



SKETCH OF PRESSURE PROBLEM

square inches. The total pressure holding the plug down is then

$$140 \times 14.186 = 1986 \textit{ pounds.}$$

To counteract this there is the atmospheric pressure, say, 15 pounds per square inch, plus the unknown pressure acting upon the 9.62 square inches of the 3½-inch circle. Then

$$9.62 \times (x + 15) = 1986$$

$$x + 15 = \frac{1986}{9.62}$$

$$x = \frac{1986}{9.62} - 15 = 191.44 \textit{ pounds}$$

per square inch.

Surfaces may be ground so finely that it takes a greater force to separate them than that required to overcome the atmospheric pressure. This force depends upon the perfection of the surfaces and is obtainable only with the fine grinding used upon the finest gages. It has not been considered here.

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Contents

PAGE

Olympic and Titanic, Ocean Giants..... 44
Disastrous Air Explosions..... 47
Features of the Leblanc Air Pump..... 48
Colors of Piping..... 49
Results of the Boston Anti-Smoke Law... 50
Efficiency of Rope Drives..... 51
Effect of Soot on Boiler Performance..... 51
The Steam Turbine in Germany..... 52
The World's Largest Crane..... 55
Intake Manifolds for Multicylinder Engines 56
Correcting Back Firing and Fuel Waste in a Large Producer Gas Engine Plant... 57
Gas Producer Investigations by the United States Bureau of Mines..... 58
Annual Convention A. I. E. E. at Chicago 59
Voltage Troubles in Small Alternators.... 62
Increase of Electrical Power in South Africa 62
Practical Letters:
Fuel Oil Heating and Alarm System ....Handling the Draft....Sectional Damper Regulator .... Recording Instruments for Small Plants....Main Bearing Experiences.....63-65
Discussion Letters:
Writing for the Technical Paper.... The Need of an Institute of Operating Engineers .... Central Station versus Isolated Plant....Corrosion of Steam Boilers .... Furnace Questions ....Vibration of Steam Reach Rod....How to Condense Steam....Management of Men....Value of CO_2 Recorder.....66-69
Editorials 71-72
Cold Storage Duty..... 73
Simple Ice Water Supply System..... 74
"Live" and "Dead" Frost..... 74
A Change of Suction Pressure..... 75
To Tell Wrought Iron from Cast Iron.... 75
Locating Leaky Coil in Ammonia Condenser 75

POWER

Inspecting Power Plant Apparatus

Boiler and flywheel explosions are the two main sources of serious disaster against which engineers must be on their guard.

It is assumed by a large number of engineers that the boiler is the greatest source of danger of any device in a steam plant and, consequently, more attention is given to it in the matter of inspection and repairs than to flywheels.

It is a lamentable fact, however, that hundreds of boilers are being operated by men who through neglect allow them to get into an unsafe condition. During the past twenty-five or thirty years, since boiler inspection has been carried on, thousands of boilers have been found so seriously defective that they have been condemned by the inspector examining them.

This shows that either the engineer did not know of these dangerous defects, or knowing, had no authority to make repairs.

A boiler explosion may or may not result in widespread disaster; it all depends upon the nature of the explosion. Statistics show that the percentage of boiler explosions is less than is that of flywheels, and that the average loss ratio on flywheels is more than twice the average loss ratio on steam boilers.

The average engineer will spend all of a Sunday inspecting, washing and getting a boiler ready for service, but he will not inspect a flywheel once a month.

One reason is doubtless because a boiler explosion makes a lot of noise, and a flywheel goes to pieces without very much disturbance. A column will be given to the boiler accident in the newspaper, but a few inches will generally serve for the flywheel accident, even though the loss may be several times greater than that caused by the boiler.

Publicity has much to do with public opinion regarding any matter and it is mainly because of this that engineers look upon flywheel explosions with so little concern.

Conditions have so changed over those of a few years ago—both steam pressures and flywheel-rim speed have been increased—that no engineer can rest secure reasoning that because he has never had an accident, he never will.

Safety in a steam plant requires more than reminiscences of past exploits. Past successes do not make a steam plant immune from accidents, and trusting solely to Providence is bad practice. Not only should boilers be thoroughly inspected, but the flywheel and safety devices on the engine should also receive proper attention. It is easier to prevent an accident than it is to gather up pieces of broken flywheels and repair the damage done to both engine and buildings.

Changing Numbers

The following extract from an advertisement appeared in a recent issue:

"In ordering use the new No. 10 Catalog. We have changed the figure numbers throughout, so it is very important that you have a copy to prevent confusion."

The object of the advertiser, whose announcement covers engineering specialties, was probably to secure a large number of replies, and he may have accomplished his object; but this illustrates an unfortunate tendency on the part of many manufacturers in revising their catalogs.

When a complete catalog is issued the numbers assigned to machines, appliances or parts which are intended to promote accuracy in ordering and shipping should never be changed in subsequent editions. They ought to remain as they were originally until the machine or part is itself changed, when a new number can be assigned to it. Otherwise, the confusion, alluded to in the above advertisement inevitably results in many cases. By leaving these numbers unchanged, the manufacturer has a complete and compact record of every part designed for his machines, and the user can order spares or repairs without going into details. Otherwise, he must specify when the machine was purchased, give its type or pattern number if it has one, state dimensions, etc., if he is to feel confident that he will get what he needs. Quite frequently time or distance of delivery is an important element in ordering, and an error in shipping the wrong part may be very costly to the user. There is also the further advantage when one number invariably designates the same part that the cost of telegraphing or cabling for it is reduced to a minimum.

One of our correspondents, who called attention to the foregoing, states that

years ago he made the mistake of changing catalog numbers in repair-part lists for the engines and sawmills of the Edward P. Allis Company, of Milwaukee. A great deal of trouble resulted and it was a long time before he heard the last of it. He says that he never repeated the blunder.

Taking Stock

Once in twelve months every properly conducted manufacturing concern strikes a balance to determine what profits and losses have been made during the year.

While this balance sheet usually deals with the manufactured goods, it is equally important that careful attention be paid to the power plant. Profits and losses figure largely in the plant and therefore should be inventoried when taking stock. Sometimes a power plant which cost, say, twenty thousand dollars when new, is entered as still worth that amount. Depreciation is not always taken into account and the deteriorating plant from the office standpoint is in as good condition as when it was new.

The engine's paint may shine, its polished surfaces and generally attractive appearance may be as good as when first installed, but what is its condition? Are the valves, piston rings and brasses and bearings worn? Does it now require more fuel to operate with the same output than when the plant was new? If it does, it is not worth the amount with which it is credited.

When the cost of a manufactured article becomes excessive, the reason is quickly learned; new methods are devised and the cost of manufacture is thereby decreased.

It frequently happens that a steam plant is not producing energy at the lowest possible rate, and that little attention is given to the fact. Indeed, in many instances the actual cost per horsepower delivered by the engine is not known. The total cost of coal, oil and supplies in the year is usually available, but whether the steam plant is using two or ten pounds of coal per horsepower-hour is not always known.

Take an inventory of the steam plant; perhaps the result would be surprising. It is possible that some entries would read:

Smokestack full of holes. Result: sluggish draft; low and variable steam pressure; reduced output of factory products.

Cracked boiler setting. Result: excessive air leakage into the furnace and combustion chamber; incomplete combustion; unburned gases go up the stack; needless waste of money.

Piping leaking at joints, uncovered steam pipe and steam blowing through the stuffing box of valve. Result: useless waste of steam and increased cost of operation.

Steam valve and cylinders of pumps and engine worn. Result: excessive steam consumption and needless expenditure of money for fuel.

Such a report would start an investigation if the office once realized what such a condition meant. If an estimated loss in dollars and cents were also presented with the causes there would begin a change for the better in the steam plant.

Such conditions are not at all scarce and the plants in which they exist will probably continue to operate as heretofore. To mend matters it will be necessary to go at it systematically and get down to the causes of power-plant losses —and then stop them.

Less than 12 Per Cent. Steam Engines

The tendency to break away from the piston steam engine is evidenced by the power plant of the Turin exposition, which has a 600-horsepower compound by Tosi, of Legnano, and a 500-horsepower vertical by Swiderski, of Leipsic. Tosi has a 4500- and Swiderski a 1200-horsepower steam turbine, and Tosi a 600- and a 1200-horsepower oil engine; Sulzer Brothers, of Winterthur, and Longan & Wolf, of Milan, have an oil engine of 1000 and 450 horsepower respectively.

Thus in a total of 10,000 horsepower the piston steam engine has but 1100 against 3300 for the oil engine and 5700 for the steam turbine. There are no gas engines in the exposition.

Of course, the tendency is to exhibit and feature the new rather than the old, but such a power plant would have been undreamed of a few years ago.

Teach the Boy a Trade

In the issue of June 27, attention was called to the advisability of putting the intending young engineering student in a shop or construction work before he enters college. Having acquired this valuable experience he will be better prepared to attack practical engineering problems, and be able intelligently to choose that branch for which he is best fitted.

Just at this season the grammar schools all over the United States have turned thousands of boys away from their doors who either from choice or necessity will in the near future start in to earn their own living.

It is the boy's natural inclination to seek a position in a field where a former schoolmate has advanced to a situation paying perhaps eight or nine dollars a week.

This sum looms large in the boy's juvenile vision, notwithstanding the fact that in the great majority of instances this class of situations offers but little further remuneration and still less chances for advancement.

Taking it for granted that the boy wants to work, by all means have him taught a trade which has a future and in which he can pursue his natural bent. That many a good physician has been lost in a mediocre lawyer is no less true in the trades than in the professions. Most every boy has a taste for mechanical work of some kind or other, and he should be free to follow his inclinations without hindrance if he is expected to succeed.

It is a grave mistake for a man to argue that because he has risen from a helper in a steam plant to the position of manager or superintendent his son will necessarily be equally successful in the same line of work.

One of the highest duties of a parent or guardian owing to his boy is to be certain that the young fellow is started right, and it equally devolves upon him to so study the boy's inclinations and taste for a particular work that he be encouraged to enter a field that is best fitted to develop them.

To the boy possessed of a steady purpose in life, whether he has high ability or is but a patient plodder, there are offered great opportunities in the industrial field today. It is not exaggeration to say that the demand for young and skilled mechanics—men of brains as well as brawn, of sound judgment and resourceful—far exceeds the supply. Every large company is on the watch for such young men; they are the material of which managers, superintendents, chief engineers and other executives are made. It is easy for the industrial army to enlist its privates, but exceedingly difficult to recruit men who will in time become "officers."

Let the boy learn a trade. It is the stepping stone to success; it is the means whereby the boy in time becomes "the man who knows and does things," who merits respect and even admiration and develops into a good citizen and head of a household.

Marine engineers will generally tell you that too high a vacuum does not pay, and that they can "get more revolutions out of her" with 26 or 27 inches than with more. With the feed water heated by the exhaust of auxiliaries there seems to be no good reason why the efficiency of an engine should not improve as the vacuum is increased, and Doctor Weighton says that from 25 to 28¼ inches the gain in economy amounts to 5.1 per cent. for quadruple and 3.5 per cent. for triple.

If some engineers actually made all of the savings they claim to make, the firm could, by purchasing the same amount of coal as formerly, run the plant and have coal to sell.

Refrigeration Department

Principles and operation of ice making and refrigerating plant and machinery

Cold Storage Duty

By F. E. Matthews

It is obviously impossible to determine with any great degree of accuracy how much refrigeration it will take to cool a number of differently shaped cold-storage boxes, built by unknown methods of construction, of several different insulating materials of unknown efficiencies and various states of preservation, into which heat is admitted through the opening of doors and radiated from lights and workmen, and containing unknown quantities of different kinds of products of varying heat-absorbing capacities, stored for different lengths of time.

When the above list can be sufficiently reduced, however, calculations of the amount of cold-storage capacity required to satisfy a certain set of conditions can readily be made. Since lights and workmen must be employed to a greater or less extent, and since no insulation can entirely prevent the inflow of heat, only a part of the refrigeration produced by the refrigerating plant can be employed in cooling the stored products, the remainder being dissipated.

Attempts are sometimes made to estimate cold-storage duty by determining the number of cubic feet of space to be cooled and dividing that by the number of cubic feet that a ton of refrigeration is supposed to cool under average conditions. While it may be interesting to know this, such comparisons are not only meaningless but are positively misleading when the many varying conditions of operation are not definitely known. Such calculations should be made only on the basis of the greatest number of known quantities and carefully worked out assumptions regarding the remaining unknown quantities.

These determinations may be simplified by the following brief method, which, together with the accompanying tables will, when judiciously applied, be found accurate enough for all ordinary commercial requirements.

The total amount of heat that the refrigerating machine must remove from the cold-storage compartment is made up as follows: Latent and sometimes specific heat of the products stored, heat evolved by lights, heat given off by workmen, heat absorbed in the precipitation and freezing of moisture, heat of air entering through open doors, and heat entering through the cold-storage insulation. All of these items will be given attention in this and later issues.

Cooling the Product

The amount of refrigeration required to cool a given amount of food product through a given range in temperature is a practically fixed quantity for a given product, but varies widely with different products. When cooling is not to be carried below the freezing point the amount of refrigeration required may be found by multiplying the specific heat of the product by the number of degrees through which it is to be cooled. If the product is also to be frozen, this amount of refrigeration must be increased by the amount of the latent heat of fusion, and if cooling is to be continued below the freezing point, the refrigeration must be further increased by the specific heat of the product below 32 degrees Fahrenheit multiplied by the number of degrees through which it is cooled below freezing point. The specific and latent heat of a number of products commonly preserved in cold storage are given in Table 1.

TABLE 1

Product	Specific Heat Above 32° F.	Latent Heat of Freezing	Specific Heat Below 32° F.
Beef—lean	0.77	102	0.41
Beef—fat	0.60	72	0.34
Butter	0.64	...	0.84
Cream	0.68	84	0.38
Eggs	0.76	100	0.40
Fish	0.82	111	0.43
Milk	0.90	124	0.47
Mutton	0.67	...	0.84
Oysters	0.84	114	0.44
Poultry	0.80	105	0.42
Pork-fat	0.51	55	0.30

It is required, for example, to cool 10,000 pounds of freshly killed poultry through 68 degrees Fahrenheit. The specific heat as given in Table 1 is 0.80 The number of B.t.u. to be removed will be

$$0.80 \times 10{,}000 \times 68 = 544{,}000$$

Dividing this result by 144 (number of B.t.u. per pound of refrigeration), the amount of cooling duty is found to be 3777.7 pounds. If the poultry is frozen, the additional refrigeration required will be

$$10{,}000 \times 105 = 1{,}050{,}000 \textit{ B.t.u.}$$

or (÷ 144) 7292 pounds, and if additional cooling to zero degrees Fahrenheit is required, the additional cold necessary will be

$$10{,}000 \times 0.42 \times 32 = 134{,}000 \textit{ B.t.u.}$$

or 933.3 pounds. The total refrigeration duty required to cool the products through 68 degrees Fahrenheit, freeze it at 32 degrees Fahrenheit, and then chill it to zero degrees Fahrenheit, would be

$$3777.7 + 7292 + 933.3 = 12{,}003 \textit{ pounds}$$

or dividing by 2000 (pounds per ton), 6 tons.

Table 2 may be found convenient in estimating the amount of refrigeration required to chill beef, pork and sausage through 64 degrees Fahrenheit, or from 104 to 40 degrees Fahrenheit:

It may be noticed that ten 750-pound fat beeves, and thirty-five 250-pound hogs require one ton of refrigeration for the cooling of the meat alone. In estimating the cooling capacity of a medium for packing-house work, a ton of refrigeration is allowed for from five to seven beeves weighing from 700 to 750 pounds, and for from fifteen to twenty-four hogs weighing 250 pounds. Still another rough rule sometimes employed is to allow a ton of refrigeration for from 3000 to 4000 pounds of meats cooled. These larger figures are intended to give ample reserve capacity to provide for ordinary insulation and other losses encountered in packing-house practice.

TABLE 2. REFRIGERATION REQUIRED TO COOL MEATS

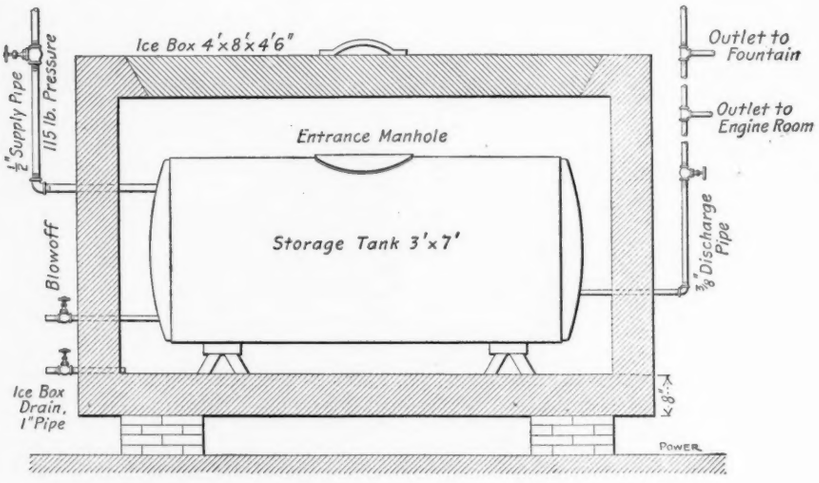
Products	Poultry	Beef Fat	Beef Medium	Beef Lean	Pork Fat	Sausage (15% Water)
Specific heat	0.80	0.60	0.68	0.77	0.51	0.65
B.t.u. to cool 1000 pounds 1° F.	800	600	680	770	510	650
B.t.u. to cool 1,000 pounds 64° F.	51,200	38,400	43,520	49,280	32,640	41,600
Pounds refrigeration per 1,000 pounds (64° F.)	355.55	266.66	302.22	333.66	226.66	228.88
Pounds of meat cooled 64° per ton refrigeration	5 625	7,500	6,615	5,844	8,765	6,923
Average weight carcass	.....	750 lb.	750 lb.	750 lb.	250 lb.	.....
Carcases cooled per ton	.....	10	8.82	7.78	35.3	.....

Simple Ice Water Supply System

By R. C. Turner

During the past ten years the manufacturers of refrigerating machinery have been building small five- and ten-ton machines, many of which have been installed in office buildings and apartment houses. In the greater number of such installations the ice machines are mostly used to cool water for drinking purposes.

In most ice-water systems the refrigerating machine is located in the basement and furnishes refrigeration to several hundred feet of cooling pipe located in an open tank holding the water to be cooled. To the tank are connected the circulating pumps which operate continuously and discharge into the balance tank on the roof. From the balance tank the water returns to its original starting point, the cooling tank, keeping up this cycle of operation during the day's or week's run.



Section through Ice Box, Showing Tank Connections

The trouble found with many systems of this kind, is that constant pumping and agitating of the water muddies it and renders it unfit for drinking purposes. Another defect is the waste of the refrigeration, owing to the use of discharge pipes and pumps which are entirely too large for the purpose. The water traveling from the pump to the roof, in these large pipes absorbs a great deal of heat from their surroundings. Where pipes of proper size with cork insulation are used, this loss of refrigerating effect can be reduced to a minimum. However, the greatest defect lies in the excessive cost of the constant pumping for the circulating of the water.

Following is a description and mode of operation of a successful system installed in one of the largest office buildings in the South, furnishing drinking water for a 17-story building containing 460 rooms:

Construction

This apparatus can be made larger or smaller to serve almost any number of rooms or people. The water-cooling tank should be made of standard boiler steel tested to 150 pounds water pressure. The entrance manhole should be of standard size as used for standard steam boilers. The gasket for the manhole should be made of soft rubber as it will come in contact with cold water only. One-inch flanges riveted on should be used for all pipe connections. The flanges should be placed on the tank as follows: For the water supply, 3 inches from the top on one end; for the discharge, 6 inches from the bottom on the opposite end. A blowoff connection should be provided on the bottom 6 inches from the end. The supply connections should be bushed by the erector from 1-inch to ½-inch pipe size. The discharge connections should be bushed from 1 inch to ⅜ inch.

A 1-inch galvanized pipe connection for the blowoff should be extended outside of the ice box. All pipe used should be redipped, galvanized. Any good boilermaker can supply the tank and comply with these specifications. Size of tank over all to be 7 feet long 3 feet diameter. The ice box in which the tank is placed should be 4 feet deep and lined inside with sheet copper. Walls of this box to have an insulation at least 8 inches in thickness.

Operation

In the mornings at 7 a.m., the discharge valve should be closed; then open the blowoff valve and let the tank blow off for several minutes; then shut off the fresh-water supply valve and let all the water in the tank drain out; open the manhole in the tank and put in 600 pounds of ice; close the manhole, shut off the blowoff valve and open the supply and the discharge valves. Next pack 200 pounds of ice between the outside of the tank and the walls of the box. During the winter months the ice on the inside of the tank will be unnecessary, all that would be required being 200 pounds, packed on the outside of the tank.

The tank and ice box should be located in the basement directly under the drinking fountains. The ¼-inch pipe to supply the fountains should be covered as follows: Rubber tape wrapped on tight; next, thin tarred paper; third, one thickness of common brown paper; lastly, wrap pipe full length with 1½-inch cloth tape. Test out the system for leaks before applying any pipe covering. Make the final connections to the drinking fountains with ⅜-inch brass unions. No filters are required with this system.

The pipe supplying the fountains being so small it is only necessary to draw off a couple of glasses of water before a fresh supply directly from the water-cooling tank in the basement is secured.

Where the cost of insulation for the pipes is of no object, the discharge pipe should be covered with cork instead of paper.

In several installations where this system has been installed, the pipe has been covered as follows: First, rubber tape is wrapped on the pipe; next, thin tarred paper, and then a good brand of cork covering.

"Live" and "Dead" Frost

By William L. Keil

Among refrigerating engineers the expressions "live" and "dead" frost are often heard and their significance is not always understood.

"Live" frost is that which shows on the return line coming from the different cold-storage rooms or ice-making systems connected to the suction end of the refrigerating machine. Moistened fingers placed upon it adhere to its surface. When this condition exists, the engineer should know that the frost will travel farther and eventually reach the compressor, often causing a bad smell and loss of refrigerant from the compressor piston-rod stuffing boxes. In addition to this the freezing of the packing often spoils it.

If "live" frost is found on the suction main, a trip through the different cold-storage rooms and to the ice-making systems should be made immediately to locate the coil or coils which are freezing back excessively. The coils can be found in a similar manner to which the "live" frost is detected on the main suction line near the machine. The regulating valves to these coils should be turned off a little until this adverse condition of operation is remedied.

"Dead" frost does not cause wetted fingers to adhere to it and is harmless so far as the operation of the refrigerat-

ing machines is concerned. It is also noticeable by a slight dripping of the suction main. On the other hand, an excessive dripping shows that the frost is leaving the suction main and in this event the regulating valves on the coils not freezing through properly should be slightly opened.

There are various causes which produce "live" and "dead" frost in the suction main near the ammonia compressors. "Live" frost may be caused by excessive opening of regulating valves, irregular speed of the refrigerating machine, decrease in the amount of cooling water showered over the condensers, causing a higher head pressure and reducing the capacity of the machine.

To obtain maximum capacity per revolution of the refrigerating machine, "dead" frost is desirable up to the suction-stop valve of the compressors.

It is good practice to have marks on the handwheels of the regulating valves by means of which their opening can be determined. When a regulating valve becomes clogged by scale or grit this can be noticed by the frost disappearing from the discharge end of the valve, and in this case the valve should be opened wide to permit the scale or grit to be blown through into the coils from where it will eventually pass into the scale separator, from which it can be removed as required. When the valve is thoroughly blown through, it should be placed back in the original position of best performance.

A Change of Suction Pressure

By J. M. Wauchope

The electric light and power company having taken over the local ice- and cold-storage plant to add to its 24-hour load, it was decided that some changes were necessary when motors were installed to take the place of steam engines. The engines were disconnected and the compressors and brine-circulating pump were driven by belt from a line shaft. The plant contained two vertical, dry gas compressors, one of 15 tons and the other of 6 tons refrigerating capacity. They operated with independent suction, the larger on the ice tank and the smaller on the cold-storage rooms.

Much trouble was had because of the poor insulation of the rooms, in keeping the temperature sufficiently low. The engineer had carried the suction pressure at 15 pounds, and on being asked why he did not lower it to keep the frost off the machine and get lower temperatures in the rooms, he replied that as he could not regulate the machine and had so much additional trouble with the rods the pressure was allowed to stand at 15. The machine was operating with frost all over it and it was pounding badly. The rod packing was frozen solid, of course.

The pounding was stopped first by fitting the discharge valves with heavy sheet-iron shims as they were badly worn.

In the rooms the coils were located on the side walls and consisted of six 1¼-inch pipes, there being one coil on each side wall extending the length of the room. The coils were fed liquid at the top and the suction connection was made at the bottom, as indicated in Fig. 1.

The coils were then connected in series, so that the liquid passed from one to the other and out at the top of the second coil, as indicated in Fig. 2. The speed of the machine was then lowered by placing smaller pulleys on the line shaft.

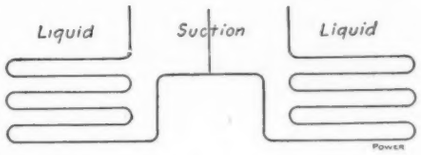


Fig. 1. Original Arrangement of Coils

As the temperature of ammonia expanding at a pressure of 15 pounds is zero it was thought that if the machine could be operated with a suction pressure of three or four pounds, the temperature then being —20 degrees, the additional difference in the temperatures of the pipes and air would result in sufficient transfer of heat to effectually cool the rooms.

On starting the machine after these changes had been made, better results were immediately obtained. The gas expanding up through the second coil was dry on reaching the compressor. Good regulation was secured, the rod packing remained elastic and the rooms were easily held at the desired temperature.

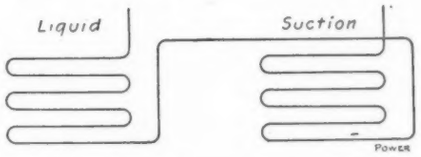


Fig. 2. Coils Connected in Series

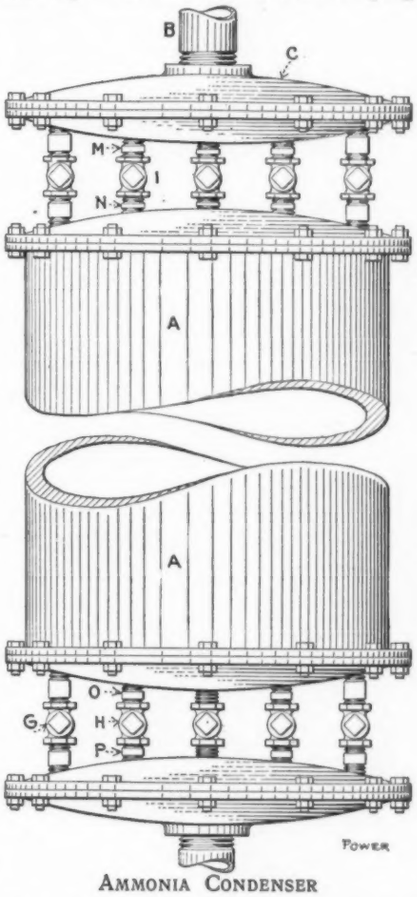
To Tell Wrought Iron From Cast Iron

Cast iron has a much higher percentage of carbon than wrought iron; hence any method of setting the surplus carbon free will serve to distinguish the cast iron. To do this, dilute a little nitric acid with three times as much water; apply a drop of the diluted acid to the iron and wash it off after a few minutes. If the spot is white, the piece was wrought iron; if black from the liberated carbon, it was cast iron.

Locating Leaky Coil in Ammonia Condenser

By James G. Sheridan

The circulating water from the absorber going to the waste tank showed evidence of an ammonia leak in the system, so it was thought advisable to test the coils in one of the condensers that was next in line for repairs. The illustration shows this particular condenser. The ammonia vapor enters the shell of the condenser and surrounds the condensing coils. The cooling and condensing water enter the junction box *C* by the pipe *B* and flows through the helical condensing coils to the lower junction box and thence to a waste tank not shown in the drawing. The nut on the back of plug



Ammonia Condenser

cock *G* was loosened enough so that the plug could be driven out sufficiently to allow some water to be drawn into a glass and, after testing, it was found that the leak was in the coil indicated by *H*. To eliminate the joints these cocks were made up with right- and left-hand nipples smeared with glycerin and litharge to insure a tight joint and which made them difficult to remove. However, after the plant was shut down, cock *H* and the corresponding cock *I* at the top of the condenser were removed by means of a hacksaw and pipe caps were placed as indicated at *M*, *N*, *O* and *P*. The defective coil was thus cut out of service and the plant was operated until the condenser was permanently repaired.

New Power House Equipment

What the inventor and the manufacturer are doing to save time and money in the engine room and power house. Engine room news

Robb-Brady Scotch Boiler

The Robb-Brady Scotch boiler is a modification of the standard Scotch type. Instead, however, of having the water and steam space contained in one shell, it is divided into two separate chambers. The greater part of the upper chamber forms the steam space. Above the furnaces the lower shell contains tubes and with the additional heating surface the shell can be made smaller in diameter than the standard Scotch type. The steam drum is attached to the main shell by connecting necks at the front and rear. About a foot above the bottom of the top drum the water line is carried, thus giving a steam space of ample volume.

The combustion chamber is cylindrical

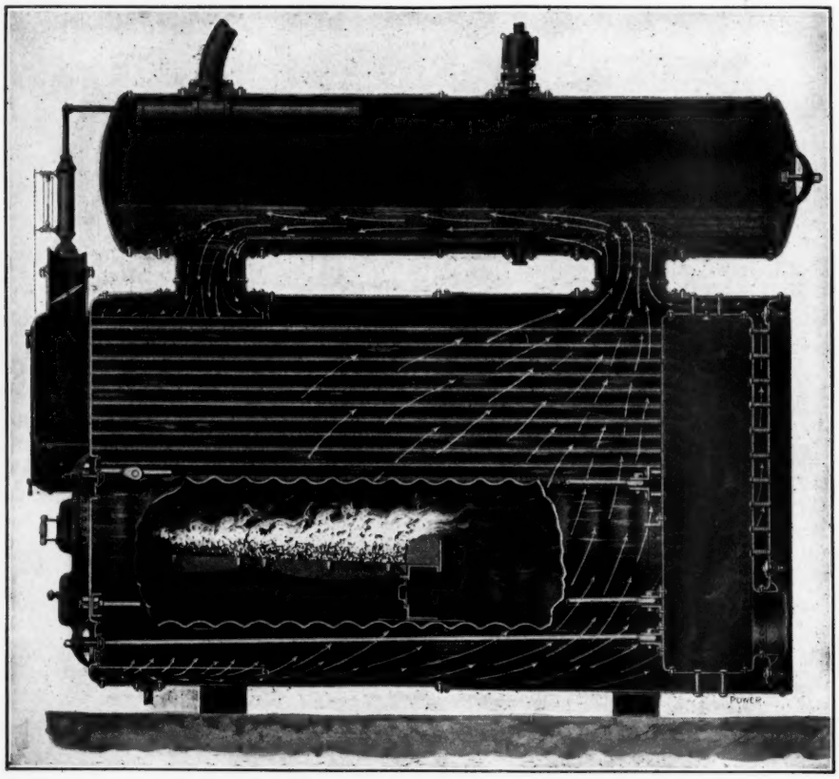


FIG. 1. SECTIONAL VIEW OF THE ROBB-BRADY SCOTCH BOILER

and short-screwed stays only are used. As the shell above the furnace is filled with tubes, longitudinal stays are not required.

The sectional view, Fig. 1, shows that the hot water and steam in the shell find an outlet to the drum only through the rear neck, as the opening through the front neck is intercepted and the circulation of the water is carried to a point below the furnaces by a circulating passage extending around the shell and having its outlet near the bottom. This is shown in Fig. 2. Therefore, the water must flow down the front neck through this passage and empty below the furnaces to replace the hot water and steam, which always take the shortest path to the top. This results in a very rapid circulation and increases the economy of the boiler, as all heating surfaces are kept clean and in condition for free transmission of heat. This complete circulation also insures an even temperature throughout the boiler with the consequent evenness in expansion, and eliminating the troubles due to the water remaining cold at the bottom of the boiler.

Manholes are provided which allow thorough inspection and cleaning. One is usually placed in the rear drum head, and in all two-furnace boilers, one above and one below the furnace in the front head. Handholes are also provided in

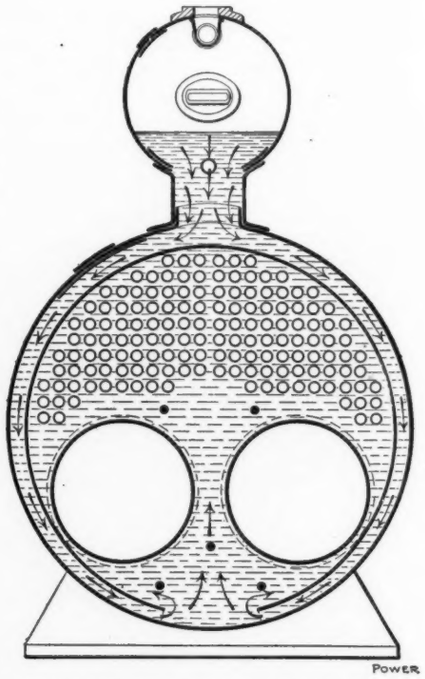


FIG. 2. SECTION THROUGH CIRCULATING PASSAGE UNDER THE FRONT NECK

suitable locations, particular attention being given to provide means for cleaning the rear tube sheet.

As the boiler is internally fired, no brick setting is necessary. The hot gases are completely surrounded by water-heating surface from the time they leave the grates until they are discharged into the smoke flue. This excludes radiation losses from the furnace, and those due to infiltration of air through the setting. The boiler is self-contained and the cost of installation is reduced to a minimum.

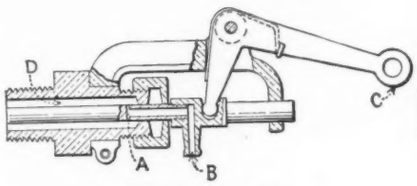
The boiler is built for marine and stationary use in units of from 50 to 300 horsepower, and for any working pressure up to 225 pounds per square inch.

This boiler is built by the Robb Engineering Company, South Framingham, Mass.

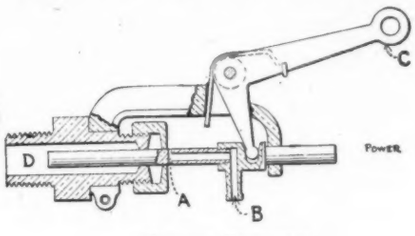
The "S-C" Gage Cock

A new design of gage cock is shown in the accompanying illustration. The cock is shown in an open and closed position. The body of the cock is made with a stuffing nut in which packing is placed to keep the valve stem tight.

This valve stem is constructed with a hollow center and has a passage to the outside through the hole *A*. On the outer end of the valve stem there is fitted an operating member which has the opening *B* to the atmosphere.



OPEN POSITION



CLOSED POSITION

The operation is simple. When the lever *C* is pulled down the arm on the inner end forces in the valve stem, so that the opening at *A* is in communication with the space *D*, which allows water to be blown out through the nipple *B*. When the lever *C* is released the valve stem is forced to a closed position and the passage *A* comes on the outside of the stuffing nut, as shown by the sketch illustrating the closed position.

This gage cock is manufactured by the "S-C" Regulator Company, Fostoria, O.

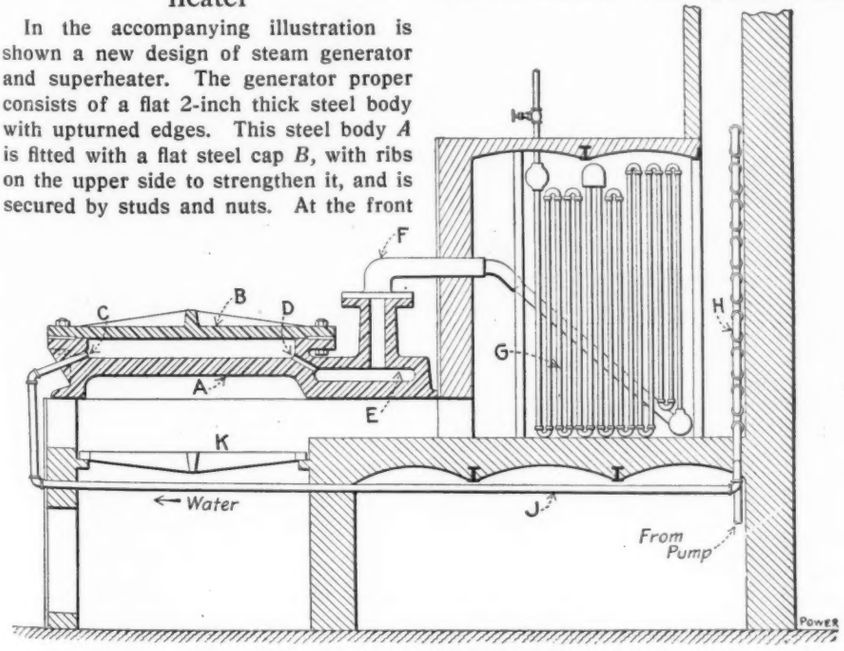
Steam Generator and Superheater

In the accompanying illustration is shown a new design of steam generator and superheater. The generator proper consists of a flat 2-inch thick steel body with upturned edges. This steel body *A* is fitted with a flat steel cap *B*, with ribs on the upper side to strengthen it, and is secured by studs and nuts. At the front is a hole in which fits a special design of nozzle, as at *C*. In the rear side of the body is a slot-like opening *D*, through which the steam enters the chamber *E*, from which it passes through the nozzle *F* to the superheater, which is made of return bends and ¾-inch tubes, as shown at *G*. A feed-water heater or economizer is placed at *H* and consists of ordinary pipe and return bends.

The operation of this steam generator is as follows: Water is forced through the coils *H* and is heated before it passes through the pipe *J*. As the water passes through the nozzle *C* it is broken up into a fine spray and immediately flashes into steam. The steam thus formed passes to the superheater which is placed directly in the path of the hot gases coming from the furnace *K*.

If an increased quantity of steam should be desired the feed pump can be speeded up and the draft in the furnace increased. The writer recently saw steam generated from zero to 95 pounds steam pressure per square inch in 60 seconds.

The superheater is fitted with a safety valve to relieve it of any excess steam pressure. Steam when first generated passes to the bottom and rear connection of the superheater so that the hottest gases strike the pipes containing the hottest steam first. The superheater and furnace are inclosed in a brick setting. This device is being handled by Charles Mullon and Ignacy Wichrawski, 186 Union avenue, Brooklyn, N. Y.



SECTIONAL VIEW OF STEAM GENERATOR

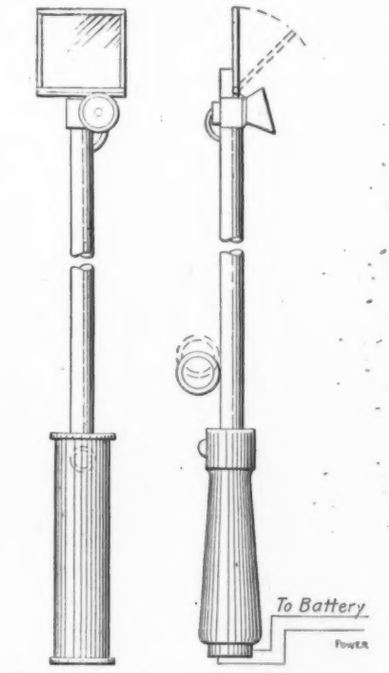
New Reflectorscope

This instrument is not only used for locating trouble around an engine, but is also available for finding troubles which cannot be observed by direct vision or reached with the hand.

The device consists of a piece of ⅜-inch seamless brass tubing, 12½ inches long, and supports a mirror holder which acts on a hinge joint at the extreme end of the tube.

The mirror is actuated 180 degrees by a ⅛-inch rod which runs from the lower end of the tube, working on a hinged joint, as shown in the illustration.

A 2-candlepower tungsten lamp is supplied with this instrument and also a battery case. For special work, where the batteries are separate, a holder 4 feet long and 10 feet of wire connected to the interior of the holder are supplied. Any lamp up to 8 volts can be used with this device.



FRONT AND SIDE VIEW OF REFLECTORSCOPE

The device can be taken apart and assembled in about one minute and will fit any miniature pocket-flashlight battery case.

It is readily seen that this device makes the inspection of the interior of an engine cylinder an easy matter, as there is no smoke or soot to prevent it. It is also convenient for use when examining the interior of a boiler.

The reflectorscope is manufactured by the Reflectorscope Manufacturing Company, White Plains avenue and Two Hundred and Forty-first street, New York City.

Lentz Poppet Valve Engine

A very simply constructed four-valve engine is illustrated and described herewith.

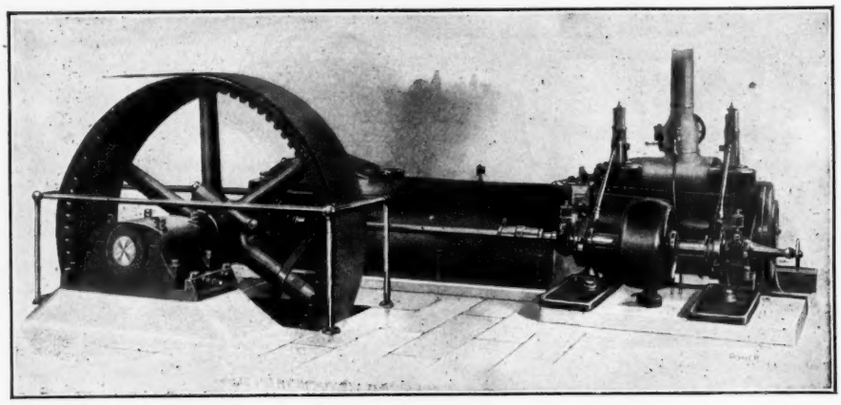


FIG. 1. SIDE VIEW OF THE LENTZ ENGINE

In Fig. 1 is shown a side view of a simple engine, of which the frame is of the girder type. In compounded engines the low-pressure cylinder is bolted to the engine frame and the high-pressure cylinder is secured to the low-pressure cylinder by a distance piece. The feet of the high-pressure cylinder are free to slide with changes of temperature on the frame.

The stuffing box is bored and ground out to 0.001 inch and in it are placed a series of cast-iron rings, turned and ground to fit. These rings, however, do not touch the piston rod. Interposed between them are five square sectional cast-iron floating rings which fit the piston rod to the same fraction of an inch. Oil can be kept circulating in the stuffing box if necessary, or water, the result of condensation, may be used.

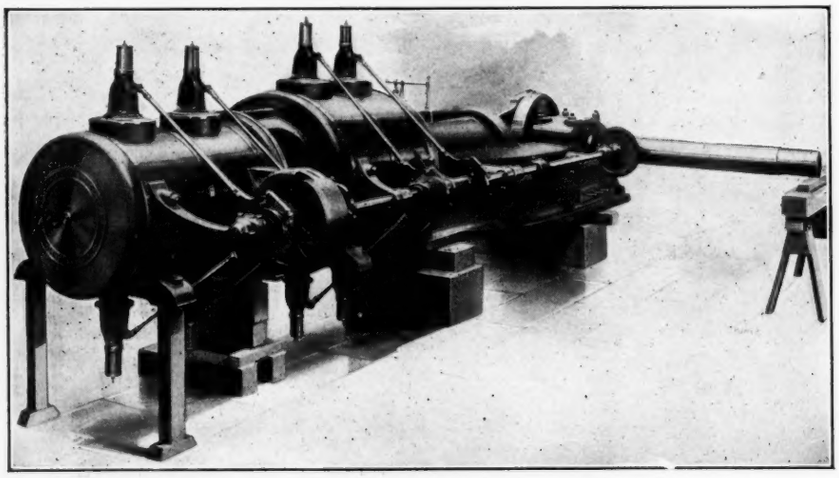


FIG. 2. SHOWING VALVE GEAR OF THE LENTZ ENGINE

All the joints in the engine are metal-to-metal, a tight fit being secured by grinding and scraping.

In Fig. 2 is shown the valve gear. The engine is fitted with double-seated poppet valves. The valve seats are ⅛ inch wide. The valve spindles have no stuffing boxes, but they fit in long bushings which are bored and ground to fit the valve spindles to 0.001 inch. Grooves to prevent leakage are turned in the spindles as shown in Fig. 3. The valves are turned to such diameters that the lower one will just pass through the upper opening. No dashpots are used to close them, but each valve is moved by a hollowed cam acting on a roller; when the valve is seated the cam is not in contact with the roller, but the clearance is very small. The roller is never clear of the cam until the valve is seated; consequently the engine runs practically noiselessly.

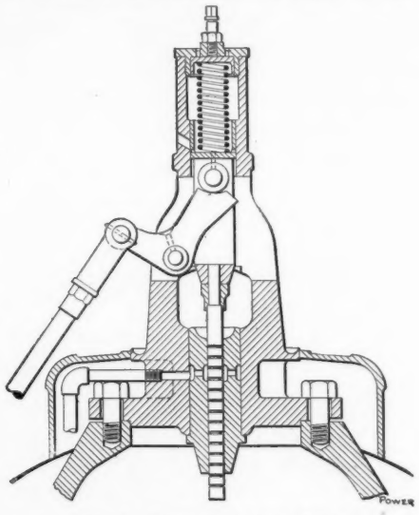


FIG. 3. STEAM VALVE GEAR

A horizontal shaft runs alongside the engine and is rotated by a bevel gear placed between it and the crank shaft. This shaft drives the valves, each valve being driven by an independent eccentric of small diameter. In order to secure smooth running, this lay shaft is driven

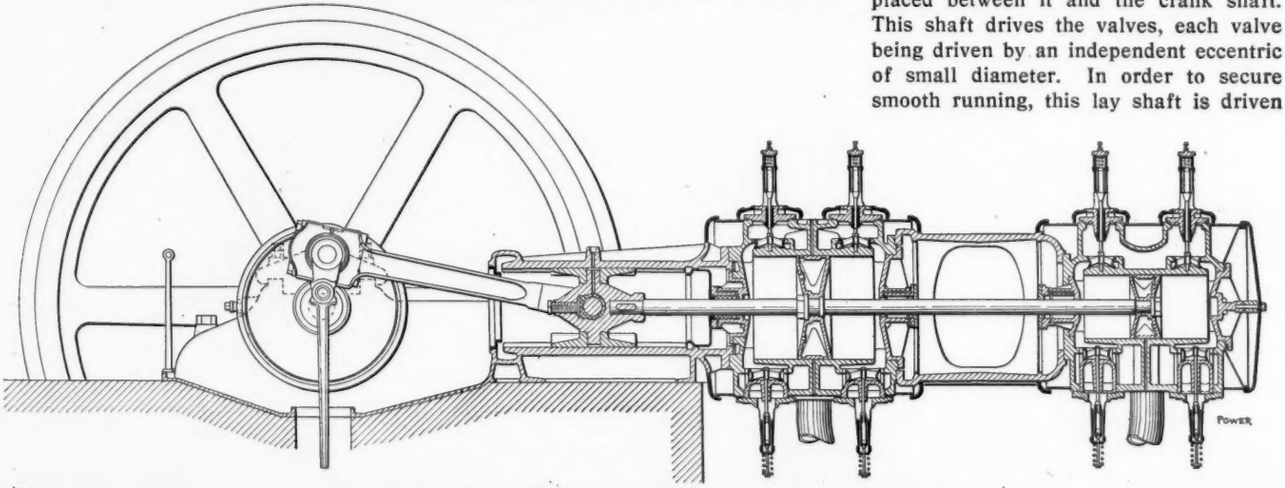


FIG. 4. SECTIONAL VIEW OF A TANDEM-COMPOUND ENGINE

by a peculiar bevel friction drive. The gears constituting this drive are in the nature of friction cones, but, to prevent slipping, they have very shallow teeth of a peculiar shape. The gears themselves are inclosed in an iron case and run with very little noise.

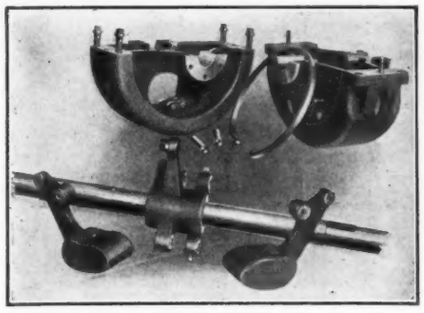


FIG. 5. PARTS OF THE GOVERNOR

Eccentrics are grouped on the shaft, one for each valve. The eccentric rods are coupled directly to the ends of the cam levers. The throw of the steam eccentrics can be reduced to zero by means of a wedge, which slides in the shaft and in the eccentrics. This wedge is moved by the governor and regulates the point of cutoff.

A sectional view of the engine is shown in Fig. 4. The governor parts are shown in Fig. 5, and the assembled governor in Fig. 6. It is simple in its construction, consisting of the inertia weight or rim, Fig. 7, two centrifugal weights *B B* and one small, flat spring *C*. The outer ring *D* runs loose on the lay shaft instead of being rigidly connected to it, and directly influences the governor spring *C* and the weights *B B*. With the slightest change of load and consequently of speed, this

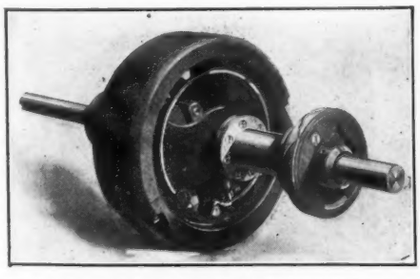


FIG. 6. GOVERNOR ASSEMBLED

inertia force acts before the centrifugal forces which have first to overcome the existing friction before they can possibly become operative. The result of this combination of inertia and centrifugal action is a greatly increased sensitiveness and quickness in action. The travel of the governor is directly transferred to the two steam eccentrics without any intermediate belts or links whereby the eccentrics are moved along a slide block, and their angular advance set according to the requirements of the load to give proper cutoff.

When desired, the engine is provided with a hand-speed adjustment and the speed of the engine can be varied while in operation.

This engine is of German design and

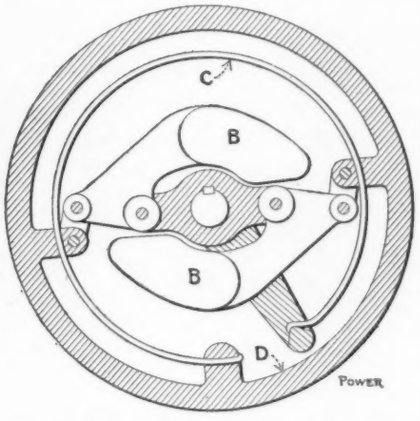
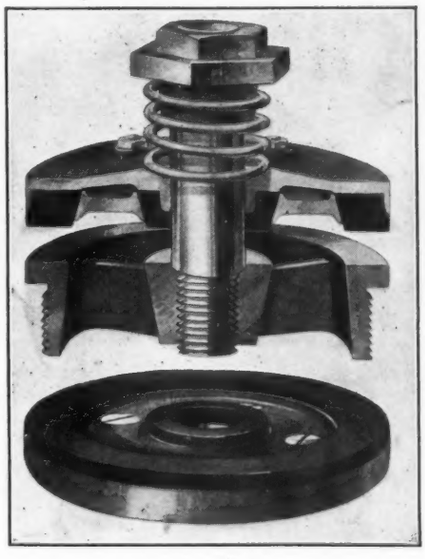


FIG. 7. OUTLINE VIEW OF THE GOVERNOR

is manufactured under United States patents by the Erie City Iron Works, Erie, Penn.

Hill Pump Valve

The accompanying illustration shows the essential features of the construction of the Hill pump valve, which is built to meet all pumping requirements, such as boiler feed, cold water, hydraulic service, etc. The valve consists of a bronze body into which are inserted an outer and an inner circle of rubber securely held by a binder ring. The rubber disks are made of varying composi-



HILL PUMP VALVE

tion according to the service for which they are to be used and are renewable.

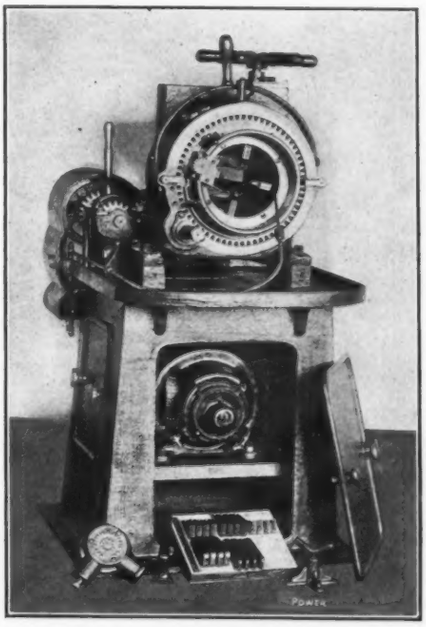
This valve provides that the bridge system in the seat may be of the most simple character, thus materially increasing the valve area, and as the valve is strongly reinforced by the metallic cover plate, as shown in the sectional view, it is especially adaptable for high pressures and heavy-service conditions. This valve is made by the Hill Pump Valve Company, 18 East Kinzie street, Chicago, Ill.

Motor Driven Pipe Threading Machine

The Curtis & Curtis Company, 85 Garden street, Bridgeport, Conn., has just placed on the market a new design of motor direct-driven pipe-cutting and threading machines, as shown in the accompanying photograph.

The die-cutting head is of the usual Forbes pattern and is mounted on a cabinet base. A motor, wound for any current desired, is concealed within the base.

The machine is entirely self-contained. There are no outside bearings to be lined up, and the entire machine is portable.



MOTOR DRIVEN PIPE-THREADING MACHINE

As no countershaft or belting is used, the operator can use a trolley over the machine for the handling of long and heavy lengths of pipe.

Various speeds can be obtained, or the machine can be started or stopped by simply throwing a lever, while the motor is allowed to run constantly.

As the motor is situated inside of the base, it is protected from drippings of oil or breakage resulting from the handling of long and heavy pipes and fittings.

The machine is heavily geared with a powerful motor, which provides ample power for dull dies or hard pipe. The machine does away with all thumb screws for adjusting the dies, which are now clamped by one movement of a lever.

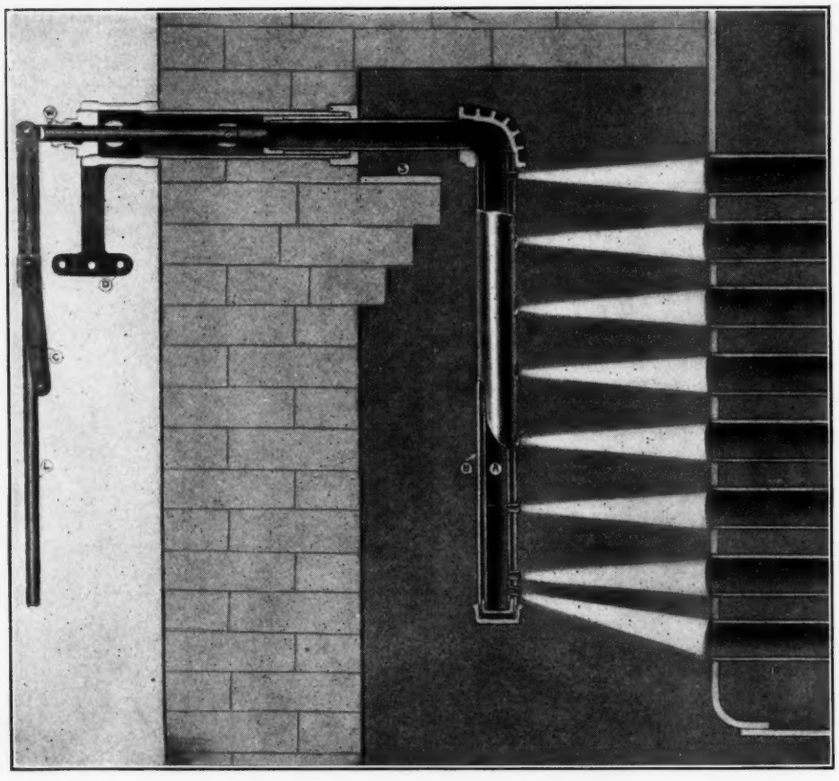
Newly Designed "Diamond" Soot Blower

A new swinging-arm blower is illustrated herewith. Its most important feature is the protection afforded to the inner steam pipe *A*. A heavy lining of insulating packing or asbestos surrounds this pipe, and this packing is in turn permanently bound by the outer iron pipe, thereby making it impossible for undue heat to reach the inner tube. A double protection also surrounds the elbow.

Another feature is the shelf *S* upon which the arm rests when not in use, and where it is out of the direct path of the heat and gases.

The sectional lever *L*, link *C* and fulcrum *D* are additional means by which the arm can be readily operated in close quarters, where otherwise it would be impossible.

This blower is made by the "Diamond" Power Specialty Company, 250 Fort street, W., Detroit, Mich.



NEW DESIGN OF DIAMOND SOOT BLOWER

Short Flexible Stuffing Box

In the description of the Short flexible stuffing box in the June 6 number, the article should have stated that the master bars have a flat face against the packing and are set at right angles to one another. The bars to which the springs are attached have two flat sides that are at right angles and the sides that come in contact with the packing are cut so as to form a circle. The device is now manufactured by the Short Flexible Stuffing Box Company, 422 First National Bank building, Denver, Colo.

Convention of International Association for the Prevention of Smoke

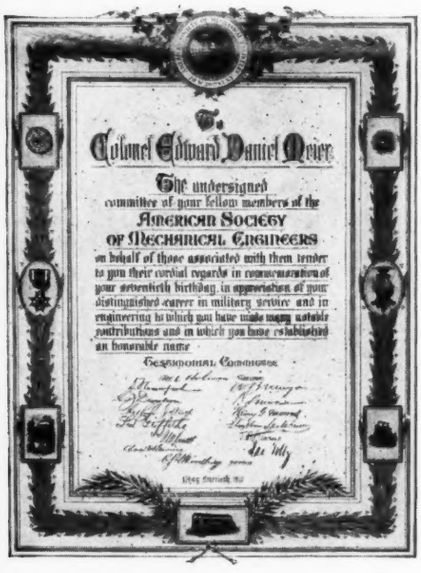
The sixth annual convention of the International Association for the Prevention of Smoke was held at Newark, N. J., on June 28, 29 and 30. The sessions were held in the city hall and the convention was welcomed to the city by Mayor Jacob Haussling. Papers were presented upon "The Relation of the Gas Producer to the Smoke Problem," by Prof. R. H. Fernald, of the Case School of Applied Science at Cleveland, and consulting engineer for the United States Bureau of Mines; "Enforcement of Smoke Prevention Ordinance," by Ernest J. Lederle, Ph. D., commissioner of health in New York City; "Smoke Prevention in Large Power Stations," by James T. Whittlesey, chief engineer, and Hervey S. Vasser, assistant chief engineer of the Public Service Corporation of New Jersey at Newark; "Smoke versus City Beauty," by Richard B. Watrous, secretary of the American Civic Association at Washington, D. C.; "The Ohio Smoke Law," by Senator John Krause, of Ohio, and two discussions, one upon mechanical stokers, steam-jet devices, special furnaces and hand firing, and one upon railroad smoke. The visitors were entertained with a theater party, a trip to Coney Island and automobile rides for the ladies.

The election resulted in the choice of Daniel Maloney, smoke inspector of the city of Newark, N. J., as president; J. T. Brown, of Indianapolis, Ind., vice-president, and R. C. Harris, of Toronto, Can., as secretary-treasurer.

The next convention will be held at Indianapolis during the last week in September of 1912.

Colonel Meier's Testimonial

The testimonial presented to Col. E. D. Meier at the Pittsburg meeting of the American Society of Mechanical Engineers is reproduced in the accompanying illustration. The presentation was made in commemoration of his seventieth birthday and was given attention in our report of the spring meeting in the June 13 number.


To
Colonel Edward Daniel Meier
The undersigned
committee of your fellow members of the
AMERICAN SOCIETY
OF MECHANICAL ENGINEERS
on behalf of those associated with them tender to you their cordial regards in commemoration of your seventieth birthday, in appreciation of your distinguished career in military service and in engineering to which you have made many notable contributions and in which you have established an honorable name
TESTIMONIAL COMMITTEE

SOCIETY NOTE

The administration of W. W. Freeman as president of the National Electric Light Association came to a close, June 30, with a total of no less than 9214 members. He began his term with 5736 members, which would give a gain of 3478 for the twelve months. It is believed that the coming year under President Gilchrist may see the figures equaled, as there is a strong movement on foot in all parts of the country toward the formation of company sections and the affiliation of State associations. There are indications that the membership during the coming year will easily reach not less than 12,000.

NEW PUBLICATION

"The Resistance to Flow through Locomotive Water Columns," by Arthur N. Talbot and Melvin L. Enger, is the title of Bulletin No. 48 just issued by the engineering-experiment station of the University of Illinois.

A locomotive water column is a device used in filling a locomotive tender with water; it is also know as a penstock, a water crane, or a standpipe. The larger locomotives have tenders holding 8000 gallons of water or more. For the faster trains the time allowed for filling is two or three minutes. This means that a large quantity of water must be discharged through the water column in a short time. To provide the large discharge, there must be little resistance to flow through the pipe line and water column, or a high pressure and high supply tank must be had. Very little definite information on the hight of tank necessary to furnish the given quantities of water has heretofore been available. Bulletin No. 48 describes tests which were made on 14 kinds of water columns, comprising practically every make now used by the railways of the United States. Much information of value to the railroads of the country is given. The discussion on water hammer, relief valves, friction losses in pipes and elbows, and methods of designing water-service installations adds to the value of the bulletin. Copies of this bulletin may be obtained gratis upon application to W. F. M. Goss, director of the engineering-experiment station, University of Illinois, Urbana, Ill.

PERSONAL

Charles E. Sweet has been appointed general superintendent of the Northway Motor and Manufacturing Company, Detroit, Mich.

Walter M. McFarland represented the Society of Naval Architects at the fiftieth congress of the Institution of Naval Architects, which was held in London on July 4.

Paul P. Bird, until recently smoke inspector for the city of Chicago, has taken a position with the contract department of the Commonwealth Edison Company, Chicago, Ill.

Frank G. Bolles is associated with the Advance Sales Corporation, New York. He was formerly connected with the Reliance Engineering and Equipment Company, Milwaukee, Wis.

Walter S. Hanson, formerly president of the El Reno Alfalfa Milling Company, El Reno, Okla., has been appointed manager of the Hollis Cotton Oil, Ice and Light Company, Hollis, Okla.

D. J. Lewis, Jr., has retired as manager of the Bundy department of the American Radiator Company, New York, and is now sales manager of the Lytton Manufacturing Corporation, New York.

Parker H. Kemble, district manager of the Edison Electric Illuminating Company, of Brooklyn, N. Y., has been appointed sales manager of the Toronto Electric Light Company, Toronto, Can.

Resolution of Thanks to Institution of Mechanical Engineers

The members of the American Society of Mechanical Engineers who enjoyed the hospitality of the Institution of Mechanical Engineers last summer have just sent to this body a beautifully engrossed resolution of thanks, a reproduction of which appears in the accompanying engraving. The appearance of the original is, of course, much better than the present illustration, but the general design and the wording will be evident.

To
The President, the Council, and the Members of
The Institution of Mechanical Engineers
The Council of The American Society of Mechanical Engineers sends
GREETING
It is difficult to put into the formal wording of preamble and resolution the sense of obligation which your guests have felt for the warmth and courtesy of their reception in England in the summer of 1910. Beginning with the Deputation representing the Lord Mayor of Liverpool, distinguished Presidents of the Institution, and others bearing good will on arrival in the Mersey, and continuing with unwearied attentions, social and professional, so planned and conducted that the memory of them, blended with the beauty of English scenery, constitute for the one hundred and forty-eight who were your guests in Birmingham, a memory of pleasure and inspiration which should be perpetual.
The joint meeting, further, was an opportunity for acquaintance between English and American engineers engaged in the great productive interests of the two countries. By encouraging the exchange of opinion upon subjects of mutual interest, the meeting has served to disclose the similarity of purpose which underlies engineering effort in all countries. It has thus promoted international good feeling, and has made possible the realization of higher ideals among the people of both nations.
Therefore be it Resolved: That the thanks of The American Society of Mechanical Engineers be, and hereby are, tendered to the Officers, Council and Members of The Institution of Mechanical Engineers for their cordial reception of the members of the American Society, and for the generous entertainment enjoyed by the visitors from their arrival at Liverpool until that memorable concluding exercise of the week, the impressive memorial service in Westminster Abbey.
The Society especially acknowledges its indebtedness to the distinguished President of the Institution, John A. F. Aspinall, Esq., and to the Members of its honorable Council for their unremitting and painstaking effort on behalf of their guests, to the Secretary of the Institution for his success in executing the carefully laid plans, and to the several Committees who planned and managed social functions and excursions. The thanks of the Society are also tendered to those various agencies, which, acting in response to its call, were made instrumental in the entertainment of its guests. The Society desires to express special appreciation for courtesies shown by the Right Honorable the Lord Mayor of Birmingham, Alderman G. H. Bowater, by the Lady Mayoress, and Ladies' Committee of Birmingham, by the Right Honorable the Earl of Dartmouth, by the Right Honorable the Earl of Clarendon, by the Right Honorable Lord Leigh, by the Mayor and others of the Corporation of Worcester, by the Very Reverend Dean of Worcester, by the Very Reverend Dean of Lichfield, by the Vice-Chancellor, Alderman G. G. Beale, by Sir Oliver Lodge, Principal of the University of Birmingham, by the Council of the Institution of Civil Engineers, by His Worship the Mayor and others of Windsor, and by the London and Northwestern, the Great Western, the Midland, and other railway companies of England. The especial thanks of the American Society are tendered also to George Tangye, Esq., a member of the Council of the Institution, for his gift to the American Society as a souvenir of its visit, of a framed autographic letter of James Watt addressed to Matthew Boulton, to Dr. and Mrs. William H. Ware, to Sir John and Lady Thornycroft and to Sir William and Lady Tritle for their social entertainments during the stay of the party in London, and finally to the Dean and Sub Dean, the Very Reverend Dr. Duckworth of Westminster for their part in the beautiful and inspiring afternoon service at Westminster Abbey.
President
Secretary

Cornelius T. Myers, formerly associated with the Wisconsin Engine Company, Corliss, Wis., as assistant secretary and assistant treasurer, has become identified with the General Motors Company, Detroit, Mich.

W. M. White, formerly hydraulic engineer with the I. P. Morris Company, Philadelphia, Penn., has assumed the duties of manager and chief engineer of the hydraulic-turbine department of Allis-Chalmers Company, Milwaukee, Wis.

A Correction

In a review of Pickworth's "Logarithms for Beginners," which recently appeared in POWER, the price is given as $1, whereas the correct figure is 50 cents.

Moments with the Ad. Editor

A department for subscribers edited by the advertising service department of Power

You've been reading about the champagne riots in France.

They are nothing more nor less than a state of almost civil war over a trade name—the use of the word "champagne."

The situation is of national importance, because of the European habit of using geographical names for trade-marks.

The French government was obliged not long ago to "delimit" the area of "Bordeaux" champagne, because it had overlapped the geographical boundaries. Growers in Aube were naming their product champagne, claiming it to have become generic.

The big growers in France are now pushed off the champagne platform with a herd of others because they did not make their products known *individually.*

In a forceful way is the power of a trade-mark being vividly demonstrated.

Conservation and popularization of trade-mark value is the foundation rock of manufacturing success.

Advertising is the modern way to *fix identity* and *affirm quality.*

* * *

All of us are not only buyers but we make something to sell and will be interested to know the limitations of the trade-mark law in the United States.

Chapman in his book on the subject states:

A trade-mark must not be identical with a registered or known trade-mark.

Must not be obviously descriptive of the character or quality of the product.

A mere proper name.

A mere geographical name.

Mere name of building or business location.

Name or picture of a living person without consent.

Mere designation of material, such as tin, paper, white leather, etc.

Designation of form, size, color or designation of package.

Merely the color of an article or its label.

It must not be composed of tne flag, coat of arms or other insignia of the United States, any state or municipality, or resemble their insignia.

A trade-mark must not be obscene or otherwise immoral.

It must not be a misrepresentation of origin, make, quality, contents or ingredients of the article with which it is associated, *nor be exploited by advertising which contains misrepresentation.*

All of these limitations are an encouragement to good advertising and a protection to buyers.

BUSINESS ITEMS

The Westinghouse Electric and Manufacturing Company, East Pittsburg, Penn., has just received an order from the Great Western Power Company, San Francisco, Cal., which calls for six 300-kva. oil-insulated, self-cooling transformers.

The town of Bellevue, Iowa, has bought two Foos producer engines, which will be used to operate the municipal electric-light plant. Both engines are of the three-cylinder vertical type and will develop 100 horsepower. It is anticipated that the installation will be made and the plant running in several weeks.

The Rateau Steam Regenerator Company, 140 Cedar street, New York, has been awarded a contract by the Delaware, Lackawanna & Western Railroad Company for a Rateau steam regenerator. This apparatus is for the Woodward collieries. The regenerator will receive the exhaust discharge of two hoisting engines and will deliver a continuous flux of steam to a low-pressure turbine of 1000 kilowatts. The heat absorption capacity of the regenerator, and therefore its heat-storage capacity, is such that it will be capable of delivering a steady flux of steam to the turbine when both hoisting engines remain idle for a period of two minutes.

NEW EQUIPMENT

Montpelier, Vt., will improve its water system.

Williamsburg, Mass., will extend its water system.

Winsted, Conn., will construct a sewer system.

Worcester, Mass., will extend its sewer system.

Shelburne Falls, Mass., will install a new water supply.

Westport, Conn., will install boilers at its power station.

The Boone (Iowa) Electric Company will enlarge its plant.

Arthur, Iowa, has voted to issue bonds for a waterworks system.

Lyle, Wash., is planning the installation of a waterworks system.

McLeod, Alberta, will install a new waterworks pumping plant.

Culbertson, Mont., has voted $39,500 bonds for waterworks system.

Mansfield, Mass., will improve its municipal electric-light plant.

Olds, Alberta, will install a complete new waterworks pumping system.

Mt. Pleasant, Utah, will install a municipal light and power plant.

Rushville, Ind., has decided to increase the capacity of the water plant.

Edmonton, Alberta, will equip a new $100,000 hydro-electric plant.

Edmonton, Alberta, will buy two new 6,000,000-gallon waterworks pumps.

The Cincinnati (Ohio) Ice Company will build an ice plant on Park avenue.

Conconully, Wash., will install a municipal light plant and waterworks system.

Vernon, B. C., will buy new dynamos and equipment for electric-lighting plant.

Lindsay, Cal., will vote on a bond issue of $75,000 for a municipal sewer system.

East Hartford, Conn., has voted $60,000 bonds for extension of its water system.

Marquette, Mich., is enlarging its municipal water power plant and electric-light plant.

Fire did $5000 damage to the plant of the Forest City Electric Company, Cleveland, O.

The Consumers Power Company, Minot, N. D., will spend $100,000 in improvements.

Middleport, N. Y., is considering the expenditure of $45,000 for a waterworks system.

Newcastle, Ind., is erecting an auxiliary water pumping plant in the factory district.

Lethbridge, Alberta, will build a large new power house for a new street-railway system.

Alex. Dufresne, Wausaukee, Wis., is planning the installation of an electric-light plant.

The Sutton Manufacturing Company, North Andover, Mass., will install two new boilers.

The Union Gas and Electric Company, Cincinnati, Ohio, is planning to build a $150,000 plant.

J. C. Claussen, Clinton, Iowa, has let contract for the construction of a cold-storage plant.

The Booth-Kelley Company, Wendling, Ore., is planning to build a new refrigeration plant.

Bonds for $16,000 have been voted at Louisville, Neb., for installing a waterworks system.

The Brattleboro (Vt.) Dairy Company will install a cold-storage plant and sterilizing equipment.

Des Moines, Iowa, has voted to purchase or build a waterworks plant. Estimated cost, $2,700,000.

Fire destroyed the power plant of the Shawnee (Okla.) Gas and Electric Company. Loss, $150,000.

Hamilton, Ont., will spend $500,000 on a new municipal power plant, also $1,000,000 for waterworks purposes.

A new boiler house is being erected at the Backus Hospital, Norwich, Conn. Three new boilers will be installed.

A new central power plant will be built at Tuskegee College, Tuskegee, Okla. W. G. Franz, Cincinnati, engineer.

The Amador Electric Light and Power Company, Sutter Creek, Cal., will build a new substation at Jackson, Cal.

The Rogue River Electric Company, Medford, Ore., is planning to install a lighting plant at Klamath Falls, Ore.

The South Bethlehem (Penn.) Brewing Company will make additions to its power and refrigerating equipment.

The San Joaquin Light and Power Company, Fresno, Cal., is planning to build a substation at Los Banos, Cal.

Power-plant equipment will be required for the eight-story hotel to be built by the Amos Brown estate at Seattle, Wash.

The Northern Idaho & Montana Power Company will install pressure pumps in its power plants at Kalispel, Mont.

A cyclone destroyed the power plant of the Phœnix-Glendale Interurban Electric Company, at Orangewood, Ariz. Will be rebuilt.

Plans have been completed for a $50,000 power house for the Philadelphia (Penn.) Electric Company, at Twenty-sixth and Christian streets.

The Osage Manufacturing Company, Nelagony, Okla., has started work on a new electric-light and ice plant. A. E. Hathaway, chief engineer.

The Bakersfield (Cal.) Ice Delivery Company, which is now planning the erection of a cold-storage plant at Taft, will also build one at Maricopa.

The Quaker City Morocco Company, Camden, N. J., which is to build a new factory in Philadelphia, will be in the market for new engines and boilers.

Hotel Chelsea, 222 West Twenty-Third street, New York, is in the market for two boilers of about 100 horsepower each. Geo. W. Lee, chief engineer.

The Nevada Power and Transportation Company, Reno, Nev., is planning the erection of a new power plant on the Truckee river, of about 4000 horsepower.

The plant of the Kenton (Ohio) Gas and Electric Company has been purchased by the Hardin-Wyandotte Lighting Company. Work will be started at once on a new $60,000 plant.

The New York Rubber Company, Matteawan, N. Y., is to build a new boiler house and radial chimney. Equipment will include four 22-inch by 18-foot horizontal tubular boilers.

The County Electric Company, New Philadelphia, Ohio, has been incorporated with $700,000 capital to manufacture electric current by S. L. London, H. K. Cravener, L. H. Purcell, etc.

F. A. Worthley, Riverside, Cal., is at the head of a new power company which plans the erection of power plants in Inyo and San Bernardino counties. About $15,000,000 will be expended.

The Fletcher Realty Company, Indianapolis, Ind., will erect a 21-story office building on East Washington street, on the site of the old Fletcher Bank building in which a complete power paint will be installed.

The Central Ohio Power Company, Columbus, O., is being incorporated with $7,000,000 capital. Plans are being prepared by C. W. Humphrey, of Chicago, for a large power house at Beaumont, Ohio. The concern is controlled by the British Electric Traction Company, of London.

NEW CATALOGS

Schuchardt & Schutte, 90 West street, New York. Circular. Hand tachometer. Illustrated.

Mesta Machine Company, Pittsburg, Penn. Catalog. Steam-hydraulic forging and bending presses. Illustrated, 24 pages, 6x9 inches.

Chain Belt Company, Milwaukee, Wis. General Catalog No. 40. Elevating and conveying machinery. Illustrated, 278 pages, 6x9 inches.

The Rockwell Manufacturing Company, West Chester, Penn. Catalog. Keystone gasolene engines. Illustrated, 32 pages, 6x9 inches.

Dodge Manufacturing Company, Mishawaka, Ind. Booklet. Dodge solid friction clutch, Orton type. Illustrated, 18 pages, 3½x6 inches.

American District Steam Company, Lockport, N. Y. Bulletin No. 122. "District Steam Heating Plants." Paper by Paul Mueller. Illustrated.

The Cutler-Hammer Manufacturing Company, Milwaukee, Wis. Booklet. Cutler-Hammer control in New York. Illustrated, 48 pages, 5x8 inches.

General Electric Company, Schenectady, N. Y. Bulletin No. 4847. Belt-driven alternators. Form B. Illustrated, 6 pages, 8x10½ inches. Bulletin No. 4850. G. E. Edison Mazda lamps. Illustrated, 26 pages, 8x10½ inches.

HELP WANTED

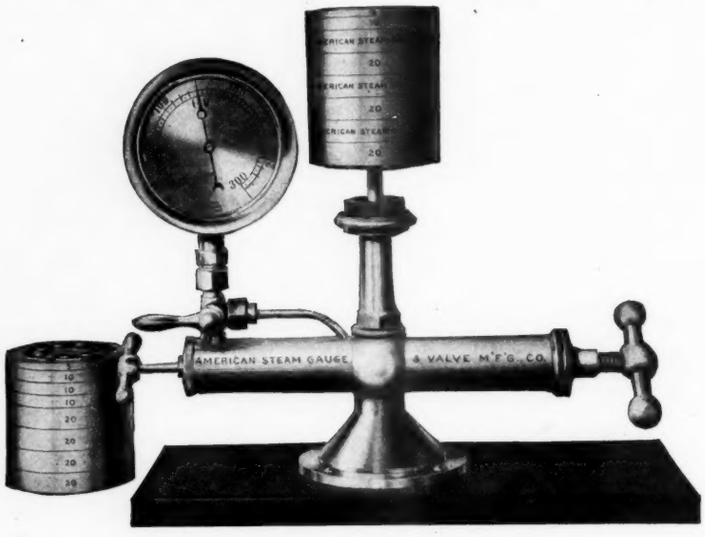
Advertisements under this head are inserted for 25 cents per line. About six words make a line.

ENGINEERS to solicit orders for the Rolin patent adjustable grate bar. Apply Standard Grate Co., Heed Bldg., Philadelphia, Penn.

WANTED—Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," POWER.

WANTED—For Pittsburg and St. Louis territory, high-grade representatives to sell first-class high-speed engine on commission basis. Preferably, representatives who are

The Modern Way To Test Accuracy of Gauges



American Dead Weight Gauge Tester

Modern because it combines all the advantages of the old-time testing devices and eliminates the disadvantages.

Does the work of the test gauge but more reliably. The test gauge itself often had to be returned to the factory for inspection or repairs.

The American Dead Weight Tester is simple and assures you of a continually accurate testing device.

It has the advantages of the mercury column enclosed in a much smaller space.

It is the ideal method for testing gauges; is thoroughly dependable, easy to operate, and costs nothing to maintain.

Send for full particulars now before you turn the page.

American Steam Gauge & Valve Mfg. Co.

Boston, Mass.

New York, 30 Church St. Atlanta, 525 Candler Bldg. Chicago, 130-132 No. Jefferson St.
Pittsburg, 8076 Jenkins Arcade Bldg. San Francisco, Monadnock Bldg. Montreal, 444 St. James St.

There's only one original J. W. Thompson Indicator —The American-Thompson—

We marketed the original THOMPSON indicator 35 years ago.

And like all things with real merit in them it has been widely imitated—

Imitated in appearance but not in quality, for the American-Thompson contains improved features that you can get in no other indicator on the market.

These imitations are advertised and marketed on our reputation.

If they are just as good as American-Thompson Indicators—if they contained all the quality features of the American-Thompson Indicator—why don't they bring the same price?

The American-Thompson price can be reduced only by skimping quality.

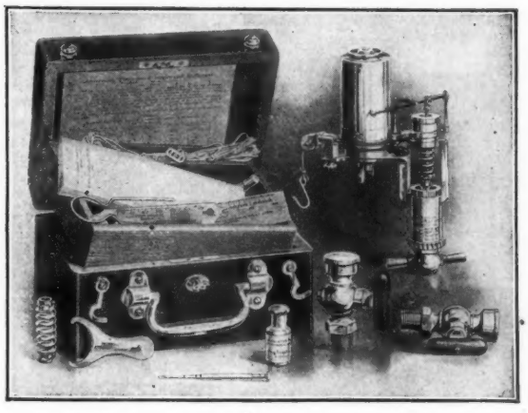
If the imitations are just as good, why didn't their makers adopt and build up a name for themselves, not appropriate ours?

The answer is sufficiently plain—the name American-Thompson has stood for quality indicator service for so long that imitators have banked on the Thompson name to hide inferiority of construction.

Can you name a single imitation as good as the original article?

So we ask—which do you want, the original or the imitation?

You can buy the original J. W. Thompson Indicator—the American-Thompson Quality Indicator—on terms that bring it easily within your means—



$5.00 Down $5.00 Monthly

The price of the whole outfit as illustrated is $55.00.

Don't be satisfied with anything but the best Any other course will prove more expensive for you in the long run.

The American-Thompson will give you lastingly accurate service—and that's what you want.

Mail us the first payment, $5.00, today and we'll ship your outfit at once with privilege of examining it for a period of five days.

You risk nothing—so act on this matter today—you'll be the gainer. Mail the coupon Now.

American Steam Gauge & Valve Mfg. Company
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American Steam Gauge & Valve Mfg. Co.
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Send me full details of your Indicator Offer No. 116

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handling power plant equipment. Box 458, POWER.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn Street, Chicago.

AGENTS WANTED for first-class steam specialty in use throughout United States. Address C. S. Wood, 410 S. 15th St., Philadelphia, Penn.

WANTED—Salesmen traveling among engineers to sell Ideal metallic packing on commission. Ideal Metallic Packing Co., South Stillwater, Minn.

WANTED—Salesmen or engineers who can sell grates, to represent the Shear Klean rocking and shearing grates. Address Chicago Grate Company, Monadnock Block, Chicago, Ill.

THE VULCAN SOOT CLEANER offers an exceptional opportunity for power specialty salesmen. For further particulars address G. L. Simonds & Co., 802 Steinway Bldg., Chicago, Ill.

SALESMAN calling at power plants to handle as a side line superior packing for steam, different from the rest and better. Nugget Packing Co., 185 Summer St., Boston, Mass.

WANTED—A reliable draftsman, with experience in designing and erecting high and low pressure steam piping and sprinkler work. American Writing Paper Company, Dept. of M. & H., Holyoke, Mass.

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WANTED—Competent engineer to take charge of gas power plant consisting of Loomis-Pettibone producers and Allis-Chalmers double acting engines; ice plant is also operated and a man who has had experience with both branches of the work will be given most consideration; state salary expected and give reference; a fine opening for the right man with proper ability to later assume entire charge of both plant and outside commercial business; population, 15,000. Ware County Light & Power Co., Waycross, Ga.

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Advertisements under this head are inserted for 25 cents per line. About six words make a line.

TECHNICAL MAN, 34, married, 13 years' experience, power, light, telephone, construction and operation, want connection as electrical engineer or superintendent, light or power plant; good business ability; prefer West or South; would consider foreign country. Box 433, POWER.

MISCELLANEOUS

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

PATENTS. C. L. Parker, Patent Attorney, ex-examiner Patent Office, 904 G St., Washington, D. C. Write for Inventor's Handbook.

EVERY ENGINEER should be posted regarding the new system of vacuum heating installed without payment of royalty; I have valuable information; write today. T. L. Reeder, 1417 W. Jackson Blvd., Chicago, Ill.

EXCLUSIVE AGENCY WANTED for Chicago territory for power plant machinery, equipment, specialties and engineers supplies; we have been established in Chicago for twenty years and are well and favorably known. Send catalog and particulars to Box 459, POWER.

RESPONSIBLE, old established, well rated company, manufacturing power plant goods and steam specialties, standard line, is establishing offices in all large cities in the United States and foreign countries; these agencies will be made with supply concerns already in business, or with individuals of suitable caliber and experience, capable of earning $5000 per year and more. In applying, please furnish both bank and other references; strictly confidential. Box 460, POWER.

FOR SALE

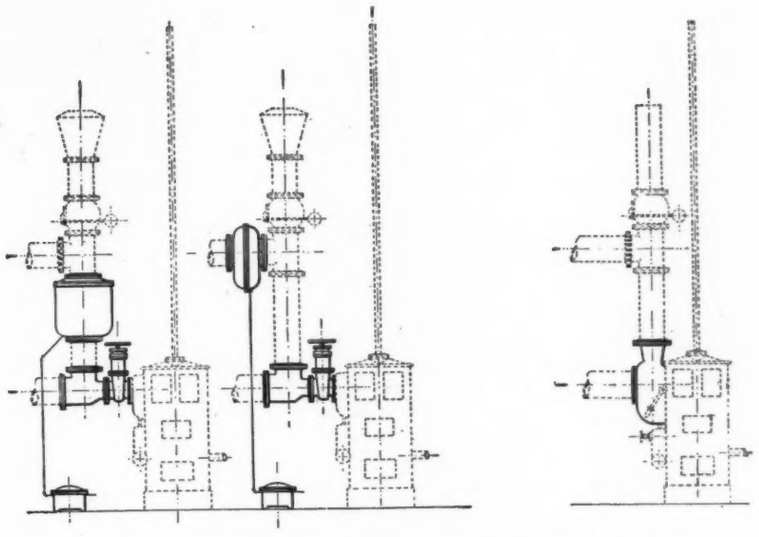
Advertisements under this head are inserted for 25 cents per line. About six words make a line.

ASHCROFT STEAM GAGES, electric high and low alarm bell attachment complete, $2.00. Troy Electrical Co., Troy, N. Y.

FOR SALE—20x48 Wheelock engine and two 72"x18' high pressure tubular boilers in good condition cheap. Address "Engineer," Box 2, Station A, Cincinnati, Ohio.

ALPHABETICAL INDEX TO ADVERTISERS

	PAGE
Air-Flex Co.	108
Albany Lubricating Co.	79
Alberger Gas Engine Co.	113
Alberger Pump Co.	93
Allis-Chalmers Co.	92
American District Steam Co.	105
American Eng. Co.	116
American Mfg. Co.	98
American Metal Hose Co.	98
American School of Correspondence	73
American Ship Windlass Co.	85
American Steam Gauge and Valve Mfg. Co. 60 and	61
Ames Iron Works	116
Anderson Co., V. D.	81
Appleby Co., Geo.	80
Armstrong Mfg. Co.	73
Ashton Valve Co.	76
Austin Separator Co.	80
Babcock & Wilcox Co.	102
Baker Valve Co.	113
Ball & Wood Co.	114
Ball Engine Co.	115
Baragwanath & Son, Wm.	94
Barnes Co., W. F. & John	113
Bayer Steam Soot Blower Co.	106
Beggs & Co., James	97
Betson Plastic Fire Brick Co.	108
Bignall & Keeler Mfg. Co.	79
Blake & Knowles Steam Pump Works	96
Bogart Gas Power Engineering Co.	112
Bowers Rubber Works	83
Bristol Co.	4th cover
Bruce-Macbeth Engine Co.	112
Buckeye Engine Co.	116
Buffalo Forge Co.	112
Builders Iron Foundry	107
Burt Mfg. Co.	18
Cade & Knapp	107
Cameron Steam Pump Works, A. S.	93
Cancos Mfg. Co.	90
Casey-Hedges Co.	103
Chaplin-Fulton Co.	104
Chapman Valve Mfg. Co.	76
Chesterton Co., A. W.	98
Cling-Surface Co.	99
Columbian Rope Co.	98
Connersville Blower Co., The	73
Consolidation Coal Co.	72
Cooper Co., C. & G.	113
Corliss Chemical Co.	108
Crosby Steam Gage & Valve Co.	103
Curtis & Curtis Co.	79
Dart Mfg. Co., E. M.	111
Davis Regulator Co., G. M.	74
Deane Steam Pump Co., The	92
Dearborn Drug & Chemical Works	5
Deming Co.	93
Detroit Lubricator Co.	80
Dexter Engineering Co., Inc.	81
Diamond Rubber Co.	89
Dixon Crucible Co., Jos.	79
Elliott Co.	7
Engineers Appliance Co., The	74
Epping-Carpenter Co.	93
Eureka Packing Co. 70 and	71
Fitchburg Steam Engine Co.	114
Foos Gas Engine Co.	111
Garlock Packing Co.	9
General Electric Co.	84
Goulds Mfg. Co., The	93
Green Engineering Co.	87
Greene, Tweed & Co., 78 and 4th	cover
Griffith & Wedge Co.	114
Griscom-Spencer Co.	96
Hammel Oil Burner Co.	90
Harbison-Walker Refractories Co.	109
Harris Steam Engine Co., W. A.	113
Harrisburg Fdry. and Mach. Works	114
Harrison Safety Boiler Wks.	63
Heine Safety Boiler Co.	102
Hewes & Phillips Iron Wks.	116
Hoffman, Geo. W.	86
Holyoke Steam Boiler Works, Inc.	105
Homestead Valve Mfg. Co.	76
Hooven, Owens, Rentschler Co.	113
Hoppes Mfg. Co.	94
Hughson Steam Specialty Co.	78
Huyette Co., Inc., Paul B.	91
Ide & Sons, A. L.	114
Ingersoll-Rand Co.	95
International Corr. Schools	67
Jamieson & Co., M. W.	91
Jefferson Union Co.	10
Jeffrey Mfg. Co., The	91
Jenkins Bros.	65
Johns-Manville Co., H. W.	87
Keeler Co., E.	102
Kellogg Co., The M. W.	73
Kennicott Co., The	78
Keystone Lubricating Co.	3
Kinkead Mfg. Co.	90
Lagonda Mfg. Co.	3d cover
Laidlaw-Dunn-Gordon Co.	98
Liberty Mfg. Co.	7
Long Grate Bar Co.	4th cover
Lunkenheimer Co.	4
Lytton Mfg. Corporation	82
McClave-Brooks Co.	14
McGraw-Hill Book Co.	110
McIntosh, Seymour & Co.	116
McLeod & Henry Co.	108
Magnolia Metal Co.	111
Manzel Bros. Co.	80
Mason Regulator Co.	76
Mellor Furnace Engr. Co.	108
Minneapolis Steel & Mach. Co.	113
Monarch Valve & Mfg. Co.	76
Morehead Mfg. Co.	82
Morrin Climax Boiler Co.	105
Morse Chain Co.	118
Murphy Iron Works	90
Nashua Machine Co.	83
National Pipe Bending Co.	95
National Tube Co.	76
Neemes Bros.	86
Nelson Valve Co.	75
New Bedford Valve Mfg. Co.	76
New Process Raw Hide Co.	98
New York & New Jersey Lubricant Co.	73
New York Belting & Packing Co., Ltd.	12
New York Edison Co.	105
Northern Equipment Co.	104
Ohio Blower Co.	69
Oil City Boiler Works	108
Oil Well Supply Co.	103
Open Coil Heater & Purifier Co.	81
Parson Mfg. Co.	85
Patterson & Co., Frank L.	95
Peerless Rubber Mfg. Co.	8
Penberthy Injector Co.	13
Pennsylvania Coal & Coke Co.	86
Pennsylvania Flexible Metallic Tubing Co.	104
Perfection Grate Co.	86
Perkins Co., Jno. B.	78
Pierce Co., Wm. B. 2d	cover
Pittsburgh Valve, Fdry. and Construction Co.	76
Power Specialty Co.	90
Precision Instrument Co.	104
Providence Engineering Wks.	114
Quaker City Rubber Co.	88
Quimby, Inc., Wm. E.	91
Reliance Gauge Column Co.	104
Remington Oil Engine Co.	111
Rhoads & Son, J. E. 1st	cover
Richardson-Phenix Co.	77
Ridgway Dynamo and Engine Co.	116
Robb Engineering Co., Ltd.	103
Robertson & Sons, Jas. L.	71
Rogers Co., H. A.	73
Rollins Engine Co.	117
Rooksby & Co., E. J.	111
"S-C" Regulator Co.	107
St. John, G. C.	90
Salamander Grate Bar Co.	86
Scaife & Sons Co., Wm. B.	107
Schade Valve Mfg. Co.	74
Schieren Co., Chas. A.	104
Schuchardt & Schutte	74
Schutte & Koerting Co.	94
Simonds & Co., G. L.	102
Skinner Engine Co.	114
Smith, Rudy & Co.	108
Smooth-On Mfg. Co.	6
Squires Co., C. E.	81
Standard Grate Co.	86
Star Brass Mfg. Co.	101
Starrett Co., L. S.	98
Struthers-Wells Co.	113
Sturtevant Co., B. F.	113
Terry Steam Turbine Co.	80
Thermoid Rubber Co.	11
Toledo Pipe Threading Machine Co.	74
Treadwell Co., M. H.	86
Trimont Mfg. Co.	100
Turbo-Blower Co.	90
Turner-Fricke Mfg. Co.	112
Uehling Instrument Co.	107
Under-Feed Stoker Company of America	85
Underwood & Co., H. B.	114
Union Steam Pump Co.	93
Universal Lubricator Co.	15
Vilter Mfg. Co.	111
Vogt Machine Co., Henry	105
Von Kokeritz & Co., R. G.	90
Vulcan Soot Cleaner Co.	102
Walton Co., F. S. 16 and	17
Washburn & Granger	85
Watson & McDaniel Co.	91
Watts-Campbell Co.	114
Westinghouse Machine Co.	118
Wheeler Condenser & Engr. Co.	91
Wheeler Mfg. Co., C. H.	92
Whitlock Coil Pipe Co.	94
Wickes Boiler Co.	102
Willcox Engineering Co.	106
Williams & Co., J. H.	86
Wing Mfg. Co., L. J.	85
Wisconsin Engine Co., The	112
Wise & Bailey	90
Worthington, Henry R.	92
Wright Mfg. Co.	80
Wyckoff & Son Co., A.	78
Yale & Towne Mfg. Co.	91
Yarnall-Waring Co.	76
Ziermore Regulator Co.	106



Comparison showing, at the left, the Extra Valves, Fittings, Separator, Trap, etc., required for an Ordinary Heater and Receiver Installation, which, at the best, is but an Imperfect Equivalent of the Cochrane Surplus Exhaust and Cut-Out Valve Heater and Receiver shown at the right.

ON REDUCING INSTALLATION COSTS

Apart from what the COCHRANE HEATER will do and save for you when in service, we believe we can help you on the installation cost.

Hundreds of the COCHRANE HEATERS sold last year (and this year also) were made up special—or provided with special features such as extra openings—specially located openings, adaptations for low head room, restricted floor space, etc., which enabled the purchaser to save money on piping, valves and connections, arrangement of apparatus and building, etc., over what they would have been compelled to expend had they purchased a standard heater.

Then, when you put in any form of closed or pressure heaters, you've got to contrive some way of keeping the oil out of them, some way of taking care of the returns, some way of adding the make-up water, etc.

Now, when you put in a COCHRANE HEATER, all these things are provided for, since these COCHRANES take the place of closed heater, independent oil separator, return and expansion tanks, steam traps, automatic raw water regulator, feed-water filter and the cost of the valves, piping, fittings and other apparatus necessary for their installation.

Quite often you can save as much as—sometimes more than—one-half the cost of the COCHRANE HEATER right in the valves and the piping that would be necessary for connecting up any other heater. This may seem strange, but it's so, as we will be glad to demonstrate any time you want to take up an actual case with us.

Talk about getting value! Just think of it—**every Cochrane Heater now in service, and there are a good many thousands, figuring up the average, is saving its owner more than twice its costs per year.**

What our apparatus does, plus what we do for you, is why we have the choicest business in the world in the Heater and Separator lines.

Try a COCHRANE just once!

Ask For Bulletin "15-H."

You Know Some Of These Concerns? They All "Use Cochranes."

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Allis-Chalmers,
Westinghouse,
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American Locomotive,
Electric Storage Battery,
Brown & Sharpe,
Carnegie Steel,
National Tube,
Jones & Laughlin,
Pullman Car Company,
American Car & Fdry. Co.,
Eastman Kodak,
American Tobacco,
International Paper,
Pabst Brewing,
Atlas Cement,
Dupont Powder,
Swift & Co.,
U. S. Metallic Cartridge,
Pyle's Pearline,
National Lead,
Standard Oil,
Douglas Shoe,
American Bridge,
Elgin Watch,
Ivory Soap,
Macbeth-Evans,
Barber Asphalt,
Berwind-White,
Aeolean Co.,
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Sherwin-Williams,
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Jno. Wanamaker,
Marshall Field,
Clieney Bros.,
Clark Thread,
Winchester Arms,
Tiffany & Co.,
International Harvester Co.,
Lehigh Valley Coal,
Penna. R. R.
N. Y. Central,
L. S. & M. S.,
Illinois Central,
C. M. & S. P.,
Canadian Pacific,
N. Y. Subway,
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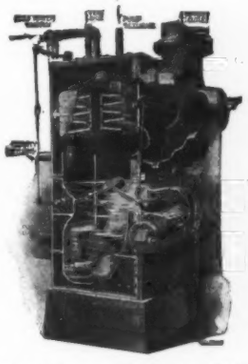


Interior View of Cochrane Steam-Stack and Cut-Out Valve Heater and Receiver.

HARRISON SAFETY BOILER WORKS

17th and Clearfield Streets **Philadelphia, Pa.**

CLASSIFIED INDEX TO ARTICLES ADVERTISED

Air Compressors
Allis-Chalmers Co..... 92
Ingersoll-Rand Co..... 95
Laidlaw-Dunn-Gordon Co.... 98
Perkins Co., Jno. B..... 78
Union Steam Pump Co..... 93

Alarms, Low Water
Detroit Lubricator Co..... 80
Elliott Co. 7
Lunkenheimer Co..... 4
Reliance Gauge Column Co...104
Wright Mfg. Co..... 80

Alternators
Allis-Chalmers Co..... 92
General Electric Co..... 84

Belt Dressing
Cling-Surface Co. 99
Garlock Packing Co..... 9
Keystone Lubricating Co.... 3
Rhoads & Son, J. E....1st cover
Schieren Co., Chas. A.....104
Smooth-On Mfg. Co..... 6
Walton Co., F. S.....16 and 17

Belt Lacing
Bristol Co.....4th cover
Schieren Co., Chas. A.....104

Belting
Diamond Rubber Co..... 89
Garlock Packing Co..... 9
Jeffrey Mfg. Co..... 91
Morse Chain Co. 118
New York Belting & Pack. Co. 10
Peerless Rubber Mfg. Co..... 8
Quaker City Rubber Works... 88
Rhoads & Son, J. E....1st cover
Schieren Co., Chas. A.....104

Belting, Chain and Drive
Morse Chain Co. 118

Belting, Rubber
Bowers Rubber Works..... 83

Blocks, Chain
Yale & Towne Mfg. Co..... 91

Blowers, Fan
Beggs & Co., James..... 97
Buffalo Forge Co.....112
Ohio Blower Co..... 69
Sturtevant Co., B. F.....113
Terry Steam Turbine Co..... 80
Turbo-Blower Co..... 90
Wing Mfg. Co., L. J..... 85

Blowers, Steam Jet
Beggs & Co., James..... 97
McClave-Brooks Co..... 14
Parson Mfg. Co..... 85
Schutte & Koerting Co..... 94

Boiler Compound
Corliss Chemical Co. 108
Dearborn Drug and Chemical Works 5
Elliott Co. 7
Johns-Manville Co., H. W.... 87
Keystone Lubricating Co.... 3

Boiler Fronts
Casey-Hedges Co.....103

Boiler Setting
Air-Flex Co. 108
Betson Plastic Fire Brick Co..108
Harbison-Walker Refractories Co. 109
McLeod & Henry Co.....108

Boiler Tube Cap Reseating Machine
Elliott Co. 7
Lagonda Mfg. Co.....3d cover
Liberty Mfg. Co..... 7
National Tube Co..... 76

Boiler Tubes
National Tube Co..... 76

Boilers
Ames Iron Works.....116
Babcock & Wilcox Co.....102
Beggs & Co., James..... 97
Casey-Hedges Co.....103
Griffith & Wedge Co.....114
Griscom-Spencer Co. 96
Harrisburg Foundry & Mach. Works 114
Harrison Safety Boiler Wks.. 63
Heine Safety Boiler Co.....102
Hewes & Phillips Iron Wks...116
Holyoke Steam Boiler Wks...105
Keeler Co., E.....102
Kennicott Co. 78
Minneapolis Steel & Mchy. Co.113
Morrin Climax Boiler Co.....105
New Bedford Valve Mfg. Co.. 76
Oil City Boiler Works.....108
Oil Well Supply Co.....103
Perkins Co., Jno. B..... 78
Robb Engineering Co., Ltd...103

Boilers—*Continued.*
Struthers-Wells Co.....113
Vilter Mfg. Co.....111
Vogt Machine Co., Henry....105
Wickes Bo"er Co.....102

Books
American School of Corr..... 73
International Corr. Schools... 67
McGraw-Hill Book Co.....110

Brick, Fire
Air-Flex Co. 108
Betson Plastic Fire Brick Co..108
Harbison-Walker Refractories Co. 109
McLeod & Henry Co.....108

Castings, Brass and Iron
Bruce-Macbeth Eng. Co.....112
Builders Iron Foundry.....107
Hooven, Owens, Rentschler Co.113
Lunkenheimer Co., The..... 4
McClave-Brooks Co..... 14
Neemes Bros..... 86
Salamander Grate Bar Co.... 86
Treadwell & Co., M. H..... 86

Castings, Steel
Hooven, Owens, Rentschler Co.113

Cement, Heat Resisting
Air-Flex Co. 108

Cement, Iron
Johns-Manville Co., H. W.... 87
Smooth-On Mfg. Co..... 6

Cement, Rubber
Peerless Rubber Mfg. Co..... 8

Chemists
Smith, Rudy & Co.....108

Chimneys, Brick
Kellogg Co., M. W..... 73

Chimneys, Steel
Keeler Co., E.....102
Morrin Climax Boiler Co.....105

Clocks
American Steam Gauge and Valve Mfg. Co.....60 and 61
Ashton Valve Co., The..... 76

Clutches, Friction
Allis-Chalmers Co..... 92

Coal
Consolidation Coal Co..... 72
Pennsylvania Coal & Coke Co. 86

Coal and Ash Handling Machinery
Green Engineering Co..... 87
Jeffrey Mfg. Co..... 91

Cocks, Blow-off
Elliott Co. 7

Cocks, Gage
American Steam Gauge and Valve Mfg. Co.....60 and 61
Chaplin-Fulton Mfg. Co.....104
Huyette Co., Paul B.....104
Jenkins Bros..... 65
Lunkenheimer Co., The..... 4
Ohio Blower Co..... 69
Reliance Gauge Column Co...104
"S-C" Regulator Co....4th cover
Star Brass Mfg. Co.....101
Wright Mfg. Co..... 80

Cocks, Steam
Dart Mfg. Co., E. M.....111
Lunkenheimer Co..... 4
National Tube Co..... 76
Schutte & Koerting Co..... 94

Combustion Chamber, Back Arch
Air-Flex Co. 108
Betson Plastic Fire Brick Co.108
Harbison-Walker Refractories Co. 109
McLeod & Henry Co.....108

Combustion Recorders
Precision Instrument Co.....104
Uehling Instrument Co.....107

Compound, Commutator
Dixon Crucible Co., Jos..... 79

Condensers
Alberger Condenser Co.....113
Allis-Chalmers Co..... 92
Anderson Co., V. D..... 81
Baragwanath & Son, Wm.... 94
Cameron Steam Pump Works, A. S..... 93
Connersville Blower Co., The. 73
Deane Steam Pump Co..... 92
Epping-Carpenter Co..... 93
Griscom-Spencer Co. 96
Kellogg Co., M. W..... 73
Minneapolis Steel & Mchy. Co.113

Condensers—*Continued.*
Schutte & Koerting Co..... 94
Union Steam Pump Co..... 93
Wheeler Cond. & Engr. Co.... 91
Wheeler Mfg. Co., C. H..... 92

Controllers, Electric
General Electric Co..... 84

Controllers, Feed Water
Chaplin-Fulton Mfg. Co.....104
Elliott Co. 7
Mason Regulator Co..... 76
Northern Equipment Co.....104
Squires Co., C. E..... 81
Ziermore Regulator Co.....106

Conveying Machinery
Jeffrey Mfg. Co..... 91

Cooling Plants
Power Specialty Co..... 90
Schutte & Koerting Co..... 94

Cooling Towers
Wheeler Cond. & Engr. Co.... 91
Wheeler Mfg. Co., C. H..... 92

Cordage
American Mfg. Co..... 98
Columbian Rope Co..... 98

Correspondence Schools
American School of Corres... 73
International Corr. Schools... 67

Couplings, Flexible Shaft
Bruce-Macbeth Engine Co..... 112
Hooven, Owens, Rentschler Co.113

Couplings, Hose
Ingersoll-Rand Co..... 95

Couplings, Pipe
Lagonda Mfg. Co.....3d cover
Liberty Mfg. Co..... 7

Coverings, Pipe and Boiler
Johns-Manville Co., H. W.... 87
Wyckoff & Son Co., A..... 78

Cranes
Yale & Towne Mfg. Co..... 91

Crank Pin Oiler
Richardson-Phenix Co. 77

Curbs, Manhole
Armstrong Mfg. Co..... 73

Cylinder Boring Bars
Underwood & Co., H. B.....114

Die Stocks
Armstrong Mfg. Co..... 73
Bignall & Keeler Mfg. Co.... 79
Curtis & Curtis Co..... 79
Toledo Pipe Threading Mach. Co. 74

Draft, Mechanical
Buffalo Forge Co.....112
Parson Mfg. Co..... 85
Schutte & Koerting Co..... 94
Sturtevant Co., B. F.....113
Turbo-Blower Co..... 90
Wing Mfg. Co., L. J..... 85

Drills, Upright
Barnes Co., W. F. & John....113

Dust Collectors
Ohio Blower Co..... 69
Sturtevant Co., B. F.....113

Dynamos
Allis-Chalmers Co..... 92
American Engine Co.....113
Bruce-Macbeth Eng. Co.....112
General Electric Co..... 84
Ridgway Dynamo and Engine Co. 116
Sturtevant Co., B. F.....113
Terry Steam Turbine Co..... 80

Economizers, Fuel
Parsons Mfg. Co..... 85
Sturtevant Co., B. F..... 80
Westinghouse Machine Co....118

Ejectors
Beggs & Co., James..... 97
Lunkenheimer Co..... 4
Penberthy Injector Co..... 13
Schutte & Koerting Co..... 94

Electric Current
New York Edison Co.....105

Engine Oil
Remington Oil Engine Co....111

Engine Repairs
Rooksby & Co., E. J.....111
Underwood & Co., H. B.....114

Engine Stops
Schutte & Koerting Co..... 94

Engines, Combustion
Alberger Gas Eng. Co..... 93
Allis-Chalmers Co..... 92
Bogart Gas Power Engineering Co. 112
Bruce-Macbeth Eng. Co.....112
Buckeye Engine Co.....116
Foos Gas Engine Co.....111
Minneapolis Steel & Mchy. Co.113
Struthers-Wells Co.....113
Turner-Fricke Mfg. Co.....112
Westinghouse Machine Co....118

Engines, Pumping
Hooven, Owens, Rentschler Co.113

Engines, Steam
Allis-Chalmers Co..... 92
American Eng. Co.....116
Ames Iron Works.....116
Ball & Wood Co.....114
Ball Engine Co.....115
Beggs & Co., James..... 97
Buckeye Engine Co.....116
Buffalo Forge Co.....112
Cooper Co., C. & G.....113
Fitchburg Steam Engine Co.. 114
Griffith & Wedge Co.....114
Griscom-Spencer Co. 96
Harris Steam Eng. Co., Wm. A.113
Harrisburg Fdry & Mach. Wks.114
Hewes & Phillips Iron Wks..116
Hooven, Owens, Rentschler Co.113
Ide & Son, A. L.....114
McIntosh, Seymour & Co....116
Minneapolis Steel & Mchy. Co.113
Perkins Co., Jno. B..... 78
Providence Engineering Wks.114
Ridgway Dynamo & Engine Co.116
Rollins Engine Co.....117
Skinner Engine Co.....114
Sturtevant Co., B. F.....113
Vilter Mfg. Co.....111
Watts-Campbell Co.....114
Westinghouse Machine Co....118
Wisconsin Engine Co.....112

Exhaust Heads
Burt Mfg. Co..... 18
Elliott Co. 7
Hoppes Mfg. Co..... 94
Ohio Blower Co..... 69
Patterson & Co., Frank L.... 95
Robertson & Sons, Jas. L.... 71
Sturtevant Co., B. F.....113
Whitlock Coil Pipe Co..... 94
Wright Mfg. Co..... 80

Expansion Joints
Alberger Condenser Co.....113
National Tube Co..... 76

Fans, Electric
General Electric Co..... 84

Fans, Exhaust and Ventilating
Anderson Co., V. D..... 81
Buffalo Forge Co.....112
General Electric Co..... 84
Power Specialty Co..... 96
Schutte & Koerting Co..... 94
Sturtevant Co., B. F.....113
Turbo-Blower Co..... 90
Wing Mfg. Co., L. J..... 85

Feed Water Weighers
Kennicott Co. 78
Wilcox Engineering Co.....106

Feeders, Boiler Compound
Richardson-Phenix Co. 77

Feeders, Furnace
Ohio Blower Co..... 69

Filters, Oil
Burt Mfg. Co..... 18
Elliott Co. 7
Liberty Mfg. Co..... 7
Richardson-Phenix Co..... 77
Robertson & Sons, Jas. L.... 71
Wright Mfg. Co..... 80

Filters, Water
Griscom-Spencer Co. 96
Scaife & Sons Co., Wm. B....107

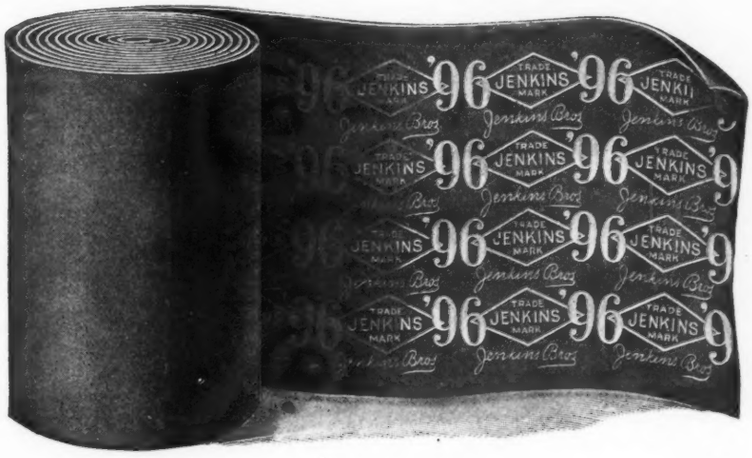
Fire Clay
Air-Flex Co. 108
Harbison-Walker Refractories Co. 109
McLeod & Henry Co.....108

Firebox Blocks
Air-Flex Co. 108
Betson Plastic Fire Brick Co.108
Harbison-Walker Refractories Co. 109
McLeod & Henry Co.....108

Fittings, Ammonia
American Steam Gauge and Valve Mfg. Co.....60 and 61

Fittings, Steel
Nelson Valve Co..... 75

JENKINS '96 PACKING



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Flanges
Ball & Wood Co.....114
Dart Mfg. Co., E. M..... 111
Jefferson Union Co..... 10
National Tube Co..... 76

Floats
Anderson Co., V. D..... 81
Schutte & Koerting Co..... 94

Flue Gas Analysis Instruments
Pierce Co., Wm. B.....2d cover

Forgings, Drop
Williams & Co., J. H..... 86

Furnace Door Arch
Air-Flex Co. 108
Harbison-Walker Refractories Co. 109
Holyoke Steam Boiler Works. 105
McLeod & Henry Co.....108

Furnace Linings
Harbison - Walker Refractories Co. 109
Holyoke Steam Boiler Works..105

Furnaces, Smokeless
Green Engineering Co..... 87
Holyoke Steam Boiler Works. 105
McClave-Brooks Co..... 14
Mellor Furnace Engr. Co.....108
Murphy Iron Works..... 90

Gage Boards
American Steam Gauge and Valve Mfg. Co.....60 and 61
Star Brass Mfg. Co.....101

Gage Glasses
American Steam Gauge and Valve Mfg. Co.....60 and 61
Chesterton Co., A. W..... 98
Garlock Packing Co..... 9
Peerless Rubber Mfg. Co..... 8
Quaker City Rubber Works... 88
Rogers Co., H. A..... 73
Von Kokeritz & Co., R. G.... 90

Gage Testing Outfit
American Steam Gauge and Valve Mfg. Co.....60 and 61
Star Brass Mfg. Co.....101

Gages, Draft
American Steam Gauge and Valve Mfg. Co.....60 and 61
Ashton Valve Co., The..... 76
Bristol Co.....4th cover
Star Brass Mfg. Co.....101

Gages, Pressure
American Steam Gauge and Valve Mfg. Co.....60 and 61
Ashton Valve Co..... 76
Crosby Steam Gage & Valve Co. 103
Star Brass Mfg. Co.....101

Gages, Recording
American Steam Gauge and Valve Mfg. Co.....60 and 61
Ashton Valve Co..... 76
Bristol Co.....4th cover
Star Brass Mfg. Co.....101
Uehling Instrument Co..... 10

Gages, Vacuum
American Steam Gauge and Valve Mfg. Co.....60 and 61
Ashton Valve Co., The..... 76
Schutte & Koerting Co..... 94
Star Brass Mfg. Co.....101

Gages, Water
American Steam Gauge and Valve Mfg. Co.....60 and 61
Greene, Tweed & Co., 78 and 4th cover
Huyette Co., Paul B..... 91
Jenkins Bros..... 65
Lunkenheimer Co..... 4
Ohio Blower Co..... 69
Reliance Gauge Column Co...104
Star Brass Mfg. Co.....101
Wright Mfg. Co..... 80

Gas Exhausters
Ohio Blower Co..... 69
Parson Mfg. Co..... 85

Gas Producers
Bogart Gas Power Engineering Co. 112
Foos Gas Engine Co.....111
Griscom-Spencer Co. 96
Minneapolis Steel & Mchy. Co.113
Wisconsin Engine Co..... 112

Gaskets
Cancos Mfg. Co..... 90
Diamond Rubber Co..... 89
Eureka Packing Co....70 and 71
Garlock Packing Co..... 9
Greene, Tweed & Co., 78 and 4th cover
Jenkins Bros..... 65
Johns-Manville Co., H. W.... 87
Keeler Co., E.....102
New York Belting & Packing Co. 12
Peerless Rubber Mfg. Co..... 8
Quaker City Rubber Works... 88

Gears
New Process Raw Hide Co... 98

Generating Sets
American Engine Co.....116
Foos Gas Engine Co.....111
General Electric Co..... 84
Harris Steam Engine Co., Wm.113
Harrisburg Foundry and Machine Works.....114
Ridgway Dynamo & Engine Co.116
Sturtevant Co., B. F.....113

Governors, Pump
Chaplin-Fulton Mfg. Co.....104
Davis Regulator Co., G. M.... 74
Elliott Co. 7
Mason Regulator Co..... 76
Northern Equipment Co.....104
"S-C" Regulator Co.....107
Squires Co., C. E..... 81
Watson & McDaniel Co..... 91
Ziermore Regulator Co.....106

Governors, Pump Speed
Mason Regulator Co..... 76
Ziermore Regulator Co.....106

Graphite
Dixon Crucible Co., Jos..... 79
Garlock Packing Co..... 9

Grates
Casey-Hedges Co.....103
Green Engineering Co..... 87
Long Grate Bar Co., 4th cover
McClave-Brooks Co..... 14
Mellor Furnace Engr. Co.....108
Neemes Bros..... 86
Perfection Grate Co..... 86
Salamander Grate Bar Co.... 86
Standard Grate Co..... 86
Treadwell & Co., M. H..... 86
Washburn & Granger Co..... 85

Grease
Albany Lubricating Co..... 79
Dearborn Drug & Chemical Works 5
Dixon Crucible Co., Jos..... 79
Keystone Lubricating Co..... 3
Walton Co., F. S.....16 and 17

Grease Extractors
American Steam Gauge and Valve Co.....60 and 61
Beggs & Co., James..... 97
Elliott Co. 7
Griscom-Spencer Co. 96

Heaters and Purifiers, Feed Water
Alberger Pump Co..... 113
Baragwanath & Son, Wm..... 94
Blake & Knowles Steam Pump Works 96
Casey-Hedges Co.....103
Elliott Co. 7
Griscom-Spencer Co. 96
Harrison Safety Boiler Wks.. 63
Hoppes Mfg. Co..... 94
Minneapolis Steel & Mchy. Co.113
National Pipe Bending Co.... 95
Open Coil Heater & Purifier Co. 81
Patterson & Co., Frank L.... 95
Robertson & Sons, Jas. L.... 71
Wheeler Mfg. Co., C. H..... 92
Whitlock Coil Pipe Co..... 94
Wickes Boiler Co.....102
Willcox Engr. Co.....106

Heating and Ventilating Systems
Dexter Engr. Co., Inc..... 81
Ohio Blower Co..... 69
Schutte & Koerting Co..... 94
Wing Mfg. Co., L. J..... 85

Heating, Central Station
American District Steam Co..105

Hoists, Combustion Engine
Foos Gas Engine Co.....111

Hoists, Electric
Allis-Chalmers Co..... 92
Yale & Towne Mfg. Co..... 91

Hoists, Hand
Yale & Towne Mfg. Co..... 91

Hose, Metal
American Metal Hose Co..... 98
Liberty Mfg. Co..... 7
Pennsylvania Flexible Metallic Tubing Co.....104
Quaker City Rubber Works... 88

Hose, Rubber
Diamond Rubber Co..... 89
Garlock Packing Co..... 9
Lagonda Mfg. Co.....3d cover
Liberty Mfg. Co..... 7
New York Belting & Packing Co. 12
Peerless Rubber Mfg. Co..... 8
Pennsylvania Flexible Metallic Tubing Co.....109
Quaker City Rubber Works... 88
Rhoads & Son, J. E.....1st cover

Ice and Refrigerating Machinery
Vilter Mfg. Co..... 111
Vogt Machine Co., Henry....105
Watts-Campbell Co. 114

Ice Machine Repairs
Underwood & Co., H. B.....114

Indicators, Ammonia
American Steam Gauge and Valve Mfg. Co.....60 and 61
Richardson-Phenix Co. 77
Star Brass Mfg. Co.....101

Indicators, Combustion Engine
American Steam Gauge and Valve Mfg. Co.....60 and 61
Richardson-Phenix Co. 77
Star Brass Mfg. Co.....101

Indicators, Speed
Star Brass Mfg. Co..... 101
Starrett Co., L. S..... 98

Indicators, Steam Engine
American Steam Gauge and Valve Mfg. Co.....60 and 61
Crosby Steam Gage & Valve Co. 103
Robertson & Sons, Jas. L.... 71
Star Brass Mfg. Co.....101

Injectors
Jenkins Bros..... 65
Lunkenheimer Co..... 4
Penberthy Injector Co..... 13
Robertson & Sons, Jas. L.... 71
Schutte & Koerting Co..... 94

Lamps, Electric
General Electric Co..... 84
Johns-Manville Co., H. W.... 87

Lathes, Foot Power
Barnes Co., W. F. & John....113

Lubricators, Cylinder
Detroit Lubricator Co..... 80
Greene, Tweed & Co., 78 and 4th cover
Griscom-Spencer Co. 96
Lunkenheimer Co..... 4
Manzel Bros. Co..... 80
Robertson & Sons, Jas. L.... 71
Richardson-Phenix Co..... 77
Star Brass Mfg. Co.....101
Universal Lubricator Co..... 15

Lubricators, Force Feed
Greene, Tweed & Co., 78 and 4th cover
Lunkenheimer Co..... 4
Richardson-Phenix Co..... 77
Star Brass Mfg. Co.....101

Machinists, General
Bruce-Macbeth Eng. Co.....112
Providence Eng. Wks.....114

Mats and Matting
Diamond Rubber Co..... 89
New York Belting & Packing Co 12
Peerless Rubber Mfg. Co.... 8

Metal, Bearing
Magnolia Metal Co.....111

Meters, Steam
General Electric Co..... 84
St. John, G. C..... 90

Meters, Water
Builders Iron Foundry.....107
Elliott Co. 7

Micrometers
Starrett Co., L. S..... 98

Milling Machines, Portable
Underwood & Co., H. B.....114

Motors, Electric
Allis-Chalmers Co..... 92
American Engine Co.....116
General Electric Co..... 84
Ridgway Dynamo & Engine Co 116
Sturtevant Co., B. F.....113

Motors, Water
Elliott Co. 7
Lagonda Mfg. Co.....3d cover
Liberty Mfg. Co..... 7

Oil and Grease Cups
Albany Lubricating Co..... 79
Detroit Lubricating Co..... 80
Keystone Lubricating Co.... 3
Liberty Mfg. Co..... 7
Lunkenheimer Co..... 4
New York & New Jersey Lubricant Co..... 73
Richardson-Phenix Co..... 77
Star Brass Mfg. Co.....101
Universal Lubricator Co..... 15

Oil Burners
Hammel Oil Burner Co..... 90
Lunkenheimer Co..... 4
Parson Mfg. Co..... 85

Oil Reservoirs
Burt Mfg. Co..... 18
Richardson-Phenix Co..... 77

Oil Tanks
Richardson-Phenix Co..... 77

Oiling Systems
Albany Lubricating Co..... 79
Burt Mfg. Co..... 18
Detroit Lubricator Co..... 80
Elliott Co. 7
Lunkenheimer Co..... 4
Richardson-Phenix Co..... 77

Oils
Albany Lubricating Co..... 79
Dearborn Drug & Chemical Works 5
New York & New Jersey Lubricant Co..... 73
Walton Co., F. S.....16 and 17

Packing, Flange
Bowers Rubber Works..... 83
Cancos Mfg. Co..... 90
Chesterton Co., A. W..... 98
Diamond Rubber Co..... 89
Eureka Packing Co....70 and 71
Garlock Packing Co..... 9
Greene, Tweed & Co., 78 and 4th cover
Jenkins Bros..... 65
Johns-Manville Co., H. W.... 87
New York Belting & Packing Co. 12
Peerless Rubber Mfg. Co..... 8
Quaker City Rubber Works... 88
Rhoads & Son, J. E.....1st cover
Smooth-On Mfg. Co..... 6
Thermoid Rubber Co..... 11
Von Kokeritz & Co., R. G.... 90
Wise & Bailey..... 90

Packing, Hydraulic
Johns-Manville Co., H. W.... 87
Quaker City Rubber Works... 88
Von Kokeritz & Co., R. G.... 90
Wise & Bailey..... 90

Packing, Pump Valve
Cancos Mfg. Co..... 90
Diamond Rubber Co..... 89
Quaker City Rubber Works... 88
Von Kokeritz & Co., R. G.... 90
Wise & Bailey..... 90

Packing, Rod
Cancos Mfg. Co..... 90
Chesterton Co., A. W..... 98
Diamond Rubber Co..... 89
Eureka Packing Co....70 and 71
Garlock Packing Co..... 9
Greene, Tweed & Co., 78 and 4th cover
Johns-Manville Co., H. W.... 87
New York Belting and Packing Co..... 12
Peerless Rubber Mfg. Co..... 8
Power Specialty Co..... 90
Quaker City Rubber Works... 88
Thermoid Rubber Co..... 11
Von Kokeritz & Co., R. G..... 90
Wise & Bailey..... 90

Pipe
Ball & Wood Co.....114
Kellogg & Co., M. W..... 73
National Tube Co..... 76

Pipe Bending
Ball & Wood Co.....114
Kellogg Co., M. W..... 73
National Pipe Bending Co.... 95
Whitlock Coil Pipe Co..... 94

Pipe Clamp
Yarnall-Waring Co..... 76

Pipe Coils
National Pipe Bending Co.... 95
National Tube Co..... 76
Whitlock Coil Pipe Co..... 94

Pipe Cutting and Threading Machines
Armstrong Mfg. Co..... 73
Bignall & Keeler Mfg. Co.... 79
Curtis & Curtis Co..... 79
Toledo Pipe Threading Machine Co..... 74
Trimont Mfg. Co.....100

Piping, Blower
Ohio Blower Co..... 69

Piping, High Pressure
Kellogg Co., M. W..... 73

Planimeters
American Steam Gauge and Valve Mfg. Co.....60 and 61
Robertson & Sons, Jas. L.... 71

Polish, Metal
Hoffman, Geo. W..... 86
Johns-Manville Co., H. W.... 87

Publishers
American School of Corr..... 73
International Corr. Schools... 67
McGraw-Hill Book Co.....116

Pulleys
Minneapolis Steel & Mchy. Co.113

Pumps, Air
Cameron Steam Pump Wks., A. S..... 93
Deane Steam Pump Co..... 92
Goulds Mfg. Co..... 93
Wheeler Cond. & Engr. Co.... 91
Wheeler Mfg. Co., C. H..... 92